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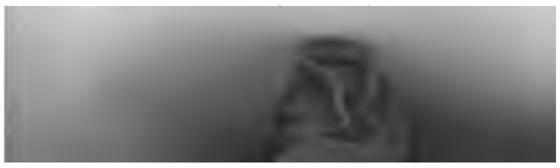

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INDEX TO VOL. V. (New Series.)

NOTE.—General Articles, Correspondence, and Companies' Meetings are indicated by ROMAN FIGURES. The heavier figures refer exclusively to NOTES. It is hoped that this distinction between the numerals will save our readers the trouble of hunting through a long string of references to notes, when perhaps they are only looking for an article or letter on the particular subject.

A.

Academie des Sciences (Paris), 61, 299
ACCIDENTS: At Brighton, 251; on Buda-Pesth Electric Railway, 321; on Electric Tramway in America, 340; in New York, 339; in Paris, 283.
Advertising, Electric, 380
African (East) Telegraphs, 61, 399
Agra Water Works, 440
Agricultural Hall Exhibition, 182, 231
Agriculture and Electricity, 22
Air Pump, Berrenberg's, 341, 440
Allen, A. H., Inverse Squares, 151
Alternate-Current Lighting in Italy, 184
Alternating Apparatus, Tests of, Duncan and Hasson, 314
Alternate Currents, Borgman's, 359
Alternating Current Induction Phenomena, E. Thomson, 332, 345; J. A. Fleming, 411, 431, 450, 474, 479
Alternating Currents, Physiological Effects of, 269, 276, 289
ALUMINIUM: In Austria, 61; Cells, 263; Smelting, Cowles *v.* Herault, 359; New Works, 299
American Finance, 480
American Institute of Electrical Engineers, 479
American Telegraphs, 399
Amiens Society, Medals Offered by, 202
Ammeter, Dovilo's, 58
Andrews, J. D. F., and Co., 361, 419
Anglo-American Telegraph Company, Meetings, etc., 21, 80, 100, 119, 280
Anglo-Portuguese Telephone Company, Meetings, etc., 260, 397
Anglo-American Brush Company (*see* BRUSH)
Annealing Metals, 202
Anthony, W. A., Electrical Theories, 198, 207
Appleton, Burbey, and Williamson's New Works, 399
Appointments, 1, 21, 41, 63, 81, 121, 122, 142, 189, 467
Arc, the Length of, 162
Arc Carbon Refuse, 102
ARC LAMPS: The Alpha, 241; Brush's Double Carbon, 43; Candle-power of, 3; Gramme's, 34; Height of, 421, 461; Intensity of in Philadelphia, 82; Nine Years with, M. D. Law, 227; at the Post Office, 61; Rotary, 121; Saunderson's, 386; Westinghouse's, 22; Westinghouse's New System, 141, 291, 339
Arc Lighting, Cost of, 102
Armature Reactions, J. Swinburne, 132, 152, 168, 237, 248
Armatures, Design of, G. K., 423
Armer, J., A Plea for the Engineer, 307
Aron's Meter, 115, 183
ARTISTIC FITTINGS: Faraday's, 142; General Electric Company's, 182; Lea's, 42; Osler's, 142; Verity's, 4
Artistic Lighting at Cooper and Co.'s, 381
Arts, Society of, Cantor Lectures by S. P. Thompson, 43, 110; Silver Medal Awarded to S. P. Thompson, 479
Atlantic Cable, The French, Repaired, 121
Atlantic Cables, New, 41, 82, 102, 142
Australia, Cables to, 480
Australia, Cable Rates to, 320, 461
Australia-New Zealand Cable, New, 379
Australasian Electric Light Company, Meetings, etc., 119
Austrian Telephone Company, Meetings, etc., 280
Ayrton, Mather, and Sumpner, Galvanometers, 99, 106, 137

B.

Bailey-Friedrich Steam Motor, The, 149
Baker, Sir B., His Joke, 359
Balloon Society's Meetings, 82, 179, 181
Barbey-Starkey's Solid Accumulators, 264
Barbey-Starkey's Accumulator Cut-Out, 425
Barraclough's Wire-Covering Machine, 208, 264
Bath Central Station, 45, 326, 507
Bath, Lighting Inspector for, 61
Bathurst's Back Block, 93
BATTERIES, PRIMARY: Aluminium Cells, 263; Baron's, 204; Bookcase of, 201; Coad's, 89, 131, 149, 172, 191; Edison and Lalande's, 141; Electrolin for, 301; A Fraud, 399; Imchenetzki's, 143; Internal Resistance of, 322; Jablochkoff's Iron, 101; King Philip Dry Cell, 439; Meyland's Dry Cell, 479; Pollak's, 224; Prevention of Creeping, 241; Schanschieff's, 223; Silvertown Dry Cell, 302; Weymersch's, 121, 161, 183, 187, 321, 510
BATTERIES, SECONDARY: Barbey-Starkey's Cut-Out, 425; Barbey-Starkey's Solid Cells, 264; Brush and Julien Patents, 300; Cellulose in Pumpelly's, 183; Chemical Theory of, 112; E.P.S. Cells for Traction Work, 381; Kohlrausch and Heim's Experiments on, 44; The Laurent Cely, 360, 502; Lithanode for, 444; Pfluger's Switch for, 430; Plates Classed as Parts of Dynamo, 459; Reynier's, 480; Salomon's Book on, 91; for Traction, Fitzgerald's Experiments, 320; for Tramcars in America, 183, 360
Bavarian Telegraphs, 284
Bell, Dr. L., Compounding Dynamos, 66
Bell, Dr. L., Motors in Railway Work, 273, 297, 317
Bell, Electric, Tumber and Company's, 397
Bell Rock Fog Signal, 163
Bells, Electric, in Asylums, 319
Bell's Telephone Patents, 161
Beloochistan, Telegraph in, 121
Belt-Slipping, Remedy for, 419
Belts, Driving, Rubber Seamless, 41
Belts, Pulleys, and Shafting, 46, 66
Benest's Cable Grapnel, 347
Benest, H., Signalling by Incandescent Lamps, 211
Berlier's Hydro-Electric Cable Railway, 203
Berly's Directory, 202
Bermuda-Halifax Cable, 402, 479, 499
Bernstein Company's Work of the Year, 12
Bernstein Lamps, 281
Bidwell, S., Thunderstorms, 124
Binswanger's Ceiling Rose, 35
Birmingham Electric Supply Company, 45
Birmingham Exhibition, 81, 121, 161, 399
Blackwall Tunnel, 221
Blake Transmitter, Carbon Deposit in, 179
Blanc et Cie., 81
Bleaching, Stepanoff's Process, 284
Bliss, G. H., Tempered Copper, 128
Blocking Orders, 3
Bludgeon, Electric, 270, 440
BOARD OF TRADE: and Electric Supply, Major Cardew, 414, 434, 454; and the Ferranti Mains, 301; and Local Authorities, 342, 502; its Model Orders, 348, 352, 361, 374, 394, 416, 436; and Municipal Corporations, 232, 261, 311; its New Offices, 2
Books Received, 41, 101, 121, 122, 142, 339
Bourne and Son, Work of the Year, 31
Bourseul, the Inventor of the Telephone, 460
Boys, C. V., Photos of Moving Objects, 476; the Oscillating Spark, 476
Bradford Station, 59
Brake for Tramcars, 182
Bramwell, Sir F., Welding by Electricity, 305
Brass, Deposition of, 300
Brazilian Rubber Trade, 64
Brazilian Submarine Company, Meetings, etc., 220, 358, 377, 458
Bremen Exhibition, 439
Bridlington Church, Electricity in, 379
Brighton Accident, 251, 258
British Association, Leeds, 402, 460
British Tanning Company's Process, 382
Brockie-Pell Lamps at the Post Office, 61
Brougham, An Electrically Lighted, 421
Brush Engine at Bath, 326
Brush and Julien Accumulator Patents, 300
Brush's Double-Carbon Arc Lamps, 43
Brush Company, Meetings, etc., 140, 200
Buoy Lighting, 84
Burglar Catching in Paris, 400
Burton's Electric Heater, 319
Business Notices, 101, 261, 299, 339, 340, 399, 459, 480 (*see also* PERSONAL)
Butcher's Cart, Electric, 322
Butter Making by Electricity, 82
Buttering Bread by Electricity, 63

C.

Cable Factory at Calais, 359
Cable Grapnel, Benest's, 347
Cable Pioneers, A Suggestion, 70
Cable Rates to Australia, 320, 461
Cable Works in Vienna, Siemens New, 141
CABLES: Broken, 21; Mackay's, 281; New, 41, 61, 82, 102, 142, 181, 379, 399, 402, 479, 480, 499; Repaired, 41, 121; Testing, Hoskier's Book on, 2, 132
Calais, Cable Factory at, 359
Caledonia, New, Cable to, 181
Callender and Company, Work of the Year, 31
Canadian Cables and Telegraphs, 21, 102, 142
Candle, An Electric, 122
Canford House, 42, 78
Cantor Lectures, S. P. Thompson, 43, 110
Caoutchouc Supply, 341, 359
Carbon Conductors, 482
Cardew, Major, Electric Supply, 414, 434, 454
Cardew's Earthing Device, 304
Cardiff, A Tale of Ancient Days, 51
Carhart, H. B., Electrical Action, 18, 38
Carpet Sewing by Electricity, 341
Carrick and Ritchie's Waverley Turbine, 424
CATALOGUES, NOTICES OF: Barraclough's, 264; Britannia Company's, 299; Crompton's, 65; Electrical Supply Company (Chicago), 42; Fowler, Lancaster, and Co.'s, 42; the Helsby, 5; Lea, Sons, and Co.'s, 42; Paterson and Cooper's, 224; Ransomes, Sims, and Jefferies, 41; Rooper and Tozer's, 440; Roper's, 261; Wehr's, 400
Caterham Lighting, 62
Causton *v.* National Telephone Company, 396
Ceiling Rose, Binswanger's, 35
Cellulose, Production of, 420
Cellulose in Pumpelly's Battery, 183
Central London Railway, 8, 62, 81, 141, 221, 322, 343, 359, 362, 380, 419, 461
Central Stations, C. J. Field, 266; C. H. Yeaman, 243
Chain Welding, 339
Challenge, A (Electrical Traction), 50
Chamberlain and Hookham, Year's Work, 32
Chatham Provisional Order, 326
Chelmsford Lighting, 81, 308, 381
Chelsea Electricity Supply Company, Meetings, etc., 138, 159
Chelsea Exhibition, 319

Chemical Society's Annual Dinner, 261
Chemico-Electrical Process of Perreur-Lloyd, 264
Chemistry, Institute of, 181
Cheque Signing by Electricity, 481
Chicago City and Engineers' Certificates, 262
Chicago Conduits, 439, 440
Chicago Telegraphs, 359
Chicago World's Fair, 241, 319
China and Japan Telephone Company, Meetings, etc., 377
China Telegraphs, 399
Chlorate of Potash, Manufacture of, 283
Cincinnati, An Electrical Engineer for, 81
Circuit Closer, Dempf's, 339
City and Guilds Old Students' Association, 49, 101
City of London and Southwark Subway Company, Meetings, etc., 160 (*see* SOUTHWARK)
City Notes, 20, 40, 60, 80, 100, 120, 140, 160, 180, 200, 220, 260, 280, 298, 318, 338, 358, 378, 396, 418, 438, 458, 478, 498, 514
Clark, Latimer, Action against by Reece, 417
Cleat, Wireman's Hand, 169
Clocks and Electricity, 201
Coad's Battery, 89, 131, 149, 172, 191
Coal, Electricity Direct from, 183
Coal in Kent, 299
Coal Mining and Electricity, 499
Cobalt Plating, A. Watt, 232
Cockburn's Double-Pole Switch, 109, 111
Colliery Signalling, 380
Column Printing Telegraph, 462, 479
Commercial Cable Company, Meetings, 280
Commercial Telegrams Bureau, 140
Commissioners of Sewers and Electric Lighting, 43, 83, 104, 164, 245, 362
Commissioners of Sewers at Taunton, 303
COMPANIES' MEETINGS, REPORTS, ETC.: Anglo-American Telegraph, 80, 100, 119, 280; Anglo-Portuguese Telephone, 260, 397; Australasian Electric Light, 119; Brazilian Submarine Telegraph, 220, 358, 377, 458; Brush Company, 26, 140, 200; Chelsea Supply Company, 138, 159; China and Japan Telephone, 377; City of London and Southwark Subway, 160; Commercial Cable 280; Consolidated Telephone, 358, 438, 457; Cuba Telegraph, 80, 119; Direct Spanish Telegraph, 160, 220, 259, 438; Direct United States Cable, 40, 60, 79, 280; Eastern Extension Telegraph, 260, 318, 336; Eastern and South African, 80; Eastern Telegraph, 60, 79, 280; Edison-Swan, 100; Electrical Engineering Corporation, 140; Electrical Engineering (Ireland), 205, 220; Globe Telegraph, 40, 260; Hastings Electric Light, 420; House-to-House, 356, 376; India Rubber, etc., 139, 159; Indo-European, 318, 356; London Electric Supply, 279; Maxim-Weston, 397; Mayfield and Co., 100; Montevideo Telephone, 318; Newcastle Electric Lighting, 259; Northampton Electric Light, 477; Notting Hill Electric Light, 180; Oriental Telephone, 298, 337, 356; Reuter's Telegram, 337; Schanschieff Battery, 21; Submarine Cables Trust, 358, 378; Submarine Telegraph, 317; Swan United, 358; Taunton Electric Light, 137; Telegraph Construction, 140, 180, 199; Telephone of Austria, 280; Telephone of Egypt, 259; United Asbestos, 200; United River Plate Telephone, 20, 59; West African Telegraph, 514; West Coast of America Telegraph, 20, 378, 397; West India and Panama, 318, 358, 377; Western and Brazilian Telegraph, 338, 378, 398; Western Counties Telephone, 456; Western Union Telegraph, 220; Westminster Electric Supply, 123, 181, 259; Woodhouse and Rawson, 81, 100
Companies, New, Register of, 20, 40, 60, 80, 100, 120, 140, 180, 220, 222, 240, 260, 298, 318, 356, 376, 381, 401, 418, 457, 478, 498, 514
Companies' Share List, 20, 60, 120, 140, 160, 180, 200, 220, 240, 260, 280, 298, 318, 338, 358, 378, 396, 418, 438, 458, 478, 498, 514
Compasses and Steel Ships, 263
Compressed Air in Paris, 2
Comstock Mine, Electrical Power at, 244
Concentric Wiring, 361
Conductors, Deterioration of 11, 31
Conduit, Tatham's, 123
Conduit System without Slots, 124
Conduits, Interior, 185
Conduits in New York, 441
Conduits, Overhead, in America, 300
Conduits (*see also* WIRES, UNDERGROUND)
Consolidated Telephone Company, Meetings, etc., 358, 438, 457
Continuous Current without Commutators, 16
Continuous Currents, Physiological Effects of, 269, 289
Cooking by Electricity, 82
Cooper and Company's Exhibition of Artistic Lighting, 381
Copper, Tempered, G. H. Bliss, 128
Coppering Tail Shafts, 123
Corporation Contracts, 422
Coulomb, Admiral, and Flashing Signals, 400
Cowles, A., Death of, 41
Cowles *v.* Herault, 339
Cox-Walker's Exhibit at Edinburgh, 489
Crompton and Company's Annual Dinner, 446
Crompton and Co., The Work of the Year, 13
Crompton *v.* Elieson, 439, 468, 475
Cuba, Spanish Cable to, 399
Cuba Telegraph Company, Meetings, 80, 119
Current Pie, 420
Cuttriss and Co., 479

D.

Daft's Power Station in Newark (U.S.), 439
Dairy, Electricity in, 82
Dangers of Electricity, 5, 11, 17, 30
Date Stamp Company's Exhibit at Edinburgh, 490
Davis and Son's Lampholders, 310
Davis and Son, John, Work of the Year, 32
Deaths from Electric Wires, 319, 339
Delaney, P. B., and the Telegraph, 82
Deprez, M., Power Transmission, 145
Deptford Station, 89, 121, 161, 301, 302, 340, 484, 488, 499
Despointes, Francois, Death of, 23
Detector, Moseley's Pocket, 288
De Tornos, Don, Death of, 43
Dick, Kerr, and Co., 440
Direct Spanish Telegraph Company, Meetings, etc., 160, 220, 259, 438
Direct United States Cable Company, Meetings, etc., 40, 60, 79, 181, 280
Directory, Berly's, 202
Discovery and Application, 242
District Railway, Electricity on, 321, 499
Dividends in Massachusetts, 379
Doors, Electric, for Theatres, 52
Dorman and Smith's Switches, 359
Dovilo's Volt and Ammeters, 58
Drake, B., Presentation to, 442
Drake and Gorham, The Work of the Year, 13
Drawbridge, Electric, 480
Drawing by Telegraph, 2
Drill for Square Holes, 340
Driving Belts, Seamless Rubber, 41
Dublin, Electrical Engineer for, 122
Dublin Gas, 399, 440
Dundee, Cable Tramway for, 420
Dynamine, New Lubricator, 283
Dynamometer, A Registering, 281
DYNAMOS: Alternate, Tests of, Duncan and Hasson, 314; Armature Reactions, J. Swinburne, 132, 152, 168, 237, 248; Design of Armatures, G. K., 423; with Composite Field, 167; Constant E.M.F. with Variable Speed, 114; Driven by Compressed Air Engine, 2; at Edinburgh Exhibition, 404; Edison's Jumbo, 300; Field-Magnet Coils, G. Kapp, 287; Fritsche's, 261; Goolden and Ravenshaw's Regulators, 446; The Helvetia, F. Guinand, 404; Mariotti's, 442; Mather and Platt's Alternate, 69; Over-Compounded, A. Dow, 304; Poleckho's, 461; Recent Improvements, 103; Rechniewski's, 234; for Refining, 399; Regnier and Bary's, 251, 344; Regulation by an Auxiliary Machine, 281; Scott and Co.'s "Tyne," 444; Some Points in Design, W. B. Esson, 172, 194, 214, 237, 248; Stanley's Alternate, 93; Statter's 101; for Telegraphy, 362; Theory of Compounding, 66; for Three-Wire System, 122; Without Commutators, 282

E.

Earthing Device, Cardew's, 304
Eastbourne Lighting, 329, 335, 340
Eastern Telegraph Company, Meetings, etc., 60, 79, 280, 320
EASTERN EXTENSION COMPANY: and Australian Tariffs, 320, 461; Meetings, etc., 260, 318, 320, 336; its New Cable, 379
Eastern and South African Telegraph Company, Meetings, etc., 80
Economy, Prodigality in, 253, 271
Edinburgh Electric Supply Corporation, 381
Edinburgh Exhibition, Miscellaneous Notes on, 4, 41, 64, 144, 181, 265, 281, 284, 321, 322, 359
Edinburgh Exhibition, Descriptive Articles: Barbey-Starkey's Exhibit, 425; Carrick and Ritchie's Exhibit, 424; Cox-Walker's Exhibit, 489; Dynamos at, 404; Electric Construction Company's Exhibit, 424; Electric Date Stamp Company's Exhibit, 490; Fairgrieve's Exhibit, 490; General Description of, 384; Glover and Co.'s Exhibit, 466; Great Western Railway's Exhibits, 503; and the Institution of Electrical Engineers, 429, 501; List of Exhibitors, etc., 374; King, Mendham, and Co.'s Exhibit, 466; Lighting of, 404; Lodge's Lightning Guard at, 399; London Committee, 443; Macdonald's Exhibit, 503; Opening Ceremony, 344; Post Office Exhibit, 404; Randall's Exhibit, 490; *Scot's Magazine* at, 404; Scott, Captain, his Exhibit, 424; Scott and Co.'s Exhibit, 444; Woodhouse and Rawson's Exhibit 425
Edison, T. A., Elected Member Berlin Electrotechnical Association, 359; his Farseeing Machine, 419; his Jumbo Dynamos, 300; Life of his Lamps, 441; Lamp Patent in Germany, 379, 460; his Ore Reducer, 380; the Paris Exhibit, 281; Pearl-street Station Burnt, 21, 103, 300
Edison Company of Boston, and Motors, 81
Edison-Lalande Battery, 141
Edison and Swan Company, Meetings, etc., 100
Egypt Telephone Company, Meetings, etc., 259
Electric Charges, Solar Action on, 222
Electric Construction Company's Exhibits at Edinburgh, 424; New Works of, 319
Electric Energy, Hospitalier's Book on, 77
Electric Investment Company, 401
Electric Lighting (Scotland) Bill, 359, 459, 501
ELECTRIC LIGHTING—
for Aberdeen, 43, 63, 161
Accident in Paris, 283
for Acton and Ealing, 41, 299, 340
at Agra, 480
and Agriculture, 22
in Algeria, 201
at Alnwick Castle, 299
in Altona, 341
in America, 2, 43, 102, 141, 339
Height of Arc Lamps, 421, 461
Artistic, at Messrs. Cooper and Co.'s, 381
Artistic Fittings for, Faraday's, 142; General Electric Company's, 182; Lea's, 42; Osler's, 142; Verity's, 4
Astonishing the Natives, 202
in Australia, 20
in Austria, 3, 23, 122, 141, 419, 439
in Empress of Austria's Villa, 439
Award to E. J. Silcock for paper on, 1
for Ayr, 21
for Bacup, 263, 459
Bad Workmanship, 150, 157, 408
for Barcelona, 281
in Barnet, 81, 459
for Barnsley, 104, 161, 177, 320, 422, 500
in Barrie (Ontario), 141
in Bath, 45, 61, 265, 326, 507
Bathurst's Back Block, 93
of Mr. Beale's Premises, Holloway-road, 242, 419, 501
for Beckenham, 82, 282
in Belgium, 21, 62, 102, 122, 141
at Belvedere Glue Works, 299
in Berlin, 81, 123, 201, 481
for Berne, 102
for Beverley, 21
Bills in the House, 161
Binswanger's Ceiling Rose, 35
for Birkenhead, 379, 400
in Birmingham, 45, 439
for Birmingham Victoria Courts, 285
Blocking Orders, 3
for Bolton, 102, 283
in *Bolton Evening News* Office, 380
in Boston (U.S.), Cost of, 101
in Bordeaux, 41
in Bradford, 3, 41, 59, 121
in Breslau Theatre, 419
for Bridlington, 104, 145, 183, 441, 459
in Bridlington Church, 379
Brighton Accident, 251, 258
in Brighton, Mr. Hedges on, 213
in Brighton, 81, 97, 182, 203, 223, 281, 341
for Bristol, 461
in British India Navigation Company's Offices, Calcutta, 399
at the British Museum, 63, 92
for Bromley, 299, 339, 363
in a Brougham, 421
in Brunn, 141, 419

ELECTRIC LIGHTING (*continued*):—
Brush (N.Y.) Company's Manager Tried for Manslaughter, 339
in Brussels, 21, 62, 102, 122, 141, 242, 401, 440, 469, 490
of Buoys, 84
on Buoys in New York Harbour, 419
in Burton-on-Trent, 460
for Bury (Lancs.), 81
for Cadiz, 62, 102
in Cairo and Alexandria Railway Stations, 1
in California and Nevada, 241
for Camberwell, 501
for Cambridge, 501
in Canada, 141
in Canford House, 42, 78
for Canterbury, 299, 421, 459
for Cardiff, 83, 360
in Carlsbad, 419
in Cassel, 161
in Castignau Torpedo Works, 241
for Caterham, 62
Central Stations, C. J. Field, 266
from Central Stations, C. H. Yeaman, 243
in the Chapel Royal, Savoy, 61
for Chatham, 300, 326, 339, 360, 479
in Chelmsford, 81, 308, 329, 381
of Chelsea Exhibition, 319
in Cheltenham, 41, 81, 460
in Chicago, 81
in China, 121, 241, 501
in Chudderghaut, 2
in the City (London), 43, 62, 83, 104 164, 245, 362
in Cologne, 181
Combination Fitting, 178
and the Commissioners of Sewers, 43, 83, 104, 164, 245, 362
Form of Contract for, 422
for Copenhagen, 459
Cost of Incandescent, 303
at the Court Theatre, A Breakdown, 379
for Coventry, 23, 161
in Cracow, 141
at Craig-y-Nos, 299
for Croydon, 123, 401
in Cuneo and Parma (Italy), 81
Dangers of, 5, 11, 17, 30, 150, 157, 319
in Denmark, 459
Deptford Station, 89, 121, 161, 301, 302, 340, 484, 488, 499
for Derry, 161
for Divers, 479
Dividends in Massachusetts, 379
in Dorchester, 283
in Dordrecht, 121
for Dortmund, 480
for Dover, 1, 320, 340, 399
in Dresden, 241
in Dublin, 122, 139, 402
in Duc de la Tremouille's House, 201
for Dundee, 4, 41, 61
for Düsseldorf, 480
for Ealing, 82
in Eastbourne, 81, 329, 335, 340
for Edinburgh, 42, 381
of the Edinburgh Exhibition, 404
Life of "Edison" Lamps, 441
Edison's Pearl-street Station, 21, 103, 300
in Egypt, 4
on the "El Khedieve," 43
at Ellenborough Colliery, 165
in Exeter, 81, 221, 440
for Fareham, 43, 121, 379
Fire Dangers, 150, 157
Fires Caused by, 5, 11, 17, 181, 283, 499
in Comte de Flandre's Palace, Brussels, 401
for Fleetwood, 439
in Florence, 241
Fog Lights for Ships, 303
for Folkestone, 142, 203, 360, 459
in France, 21, 22, 41, 48, 141, 161, 162, 201, 205, 241, 242, 379, 499
in France and Algeria, 431
in Frankfort, 292, 312, 330
French Dividends, 1
of the French Exhibition, 241
in Fulham, 243, 500
for Galway Harbour, 263
and Gas, 48, 61, 81, 82, 121, 161, 182, 230, 265, 331, 341, 399, 440, 459, 481, 499
and Gas in Montevideo, 460
Gatti's Station, 63, 82, 123, 499
in the General Post Office, 42, 61, 201
in Germany, 81, 123, 161, 181, 201, 241, 292, 319, 330, 341, 379, 419, 479, 480
for Glasgow, 459
of Glasgow Students' Bazaar, 61
for Godalming, 339
in Gorlitz, 479

ELECTRIC LIGHTING (*continued*):—
and Government Patronage, 70
for Gravesend, 61
of Grove House, Tipperary, 223
for Guadaljara (Spain), 281
in Guatemala, 61
for Halifax, 281
in the Halles Centrales, Paris, 141, 242
in Hamburg, 479
for Hanley, 62, 262
in Hanover, 101, 319
for Hardingstone, 339
for Harrogate, 101, 221
in Hastings, 420
in Helouan Casino, 4
for Hendon, 81
in Hennebont, 21
for Hertford, 43
in Holland, 261
in Holy Trinity Church, Chelsea, 397
for Homerton Workhouse, 103
in the Houses of Parliament, 103, 122, 162
for Huddersfield, 459
in Huesca, 281
for Hull, 103
in Hyderabad, 242
in Ibstock Colliery, 480
in India, 2, 182, 242, 480
in the Inner Temple, 163
Insurance of Employés, 419
of Inverary Castle, 299
for Ipswich, 1, 81, 440
for Islington, 125, 222
in Italy, 61, 81, 184, 241, 281
in Japan, 221, 229
in Kensington, Map of District, 141
in Keswick, 1, 22, 41, 407
in Konigsberg, 379
and Lambeth Vestry, 261, 279
in Lancaster, 41
in Leamington, 41, 81, 223
for Leeds, 64, 84, 342, 500
of Leeds Exhibition, 436
in Leeds, Private Stations, 22,342
for Leith, 262
Life of Lamps, 104
in Liverpool, 41, 439
and Local Authorities, by G. Offor, 179
and Local Authorities, "Too Soon," 349
Local Authorities and the Board of Trade, 342, 375, 502 (*see* MUNICIPAL)
Local Authorities *v.* Supply Companies, 250, 261, 341
Le Locle (Switzerland), 141
Locomotive Headlights, 263
in London (not City), 500
in London County Council Chamber, 339
and the London County Council, 285
in London, Main Laying, 399
in London Newspaper Offices, 462
Long Distance in Derbyshire, 162
for Loughborough, 380
on H.M.S. "Magdala" and "Abyssinia," 163
in Magdeburg Theatre, 441
in Maintz Theatre, 479
for Manchester, 379
and Marylebone Vestry, 283, 322
Medals Offered by the Amiens Society, 202
in Milan, 281
and Military Operations, 101
The Model Orders, 348, 352, 361, 374, 394, 416, 436
in Moet and Chandon's Works, 283
on the ss. "Monte Video," 340
and Morals, 102, 161
of Moss's Steamers, 101
Municipal Corporations and Board of Trade, 232, 311
National (U.S.) Association (*see* NATIONAL)
in Newcastle-on-Tyne, 22, 62, 83, 182, 261
of New Scotland Yard, 463
in New South Wales, 499
in New York, 41, 116, 141
of New Zealand Exhibition, 61
at Niagara Falls, 499
for North Berwick, 103
for Northampton, 24
for Norwich, 101, 399
for Nottingham, 2
for Notting Hill, 42
for Obscure Streets, 282
in Oldham, 459
of s.s. "Orel," 185
for Oxford, 61, 184
on the Pacific Coast, 241
for Paddington, 244, 281, 320, 340, 399, 420, 447, 467
in Paris, 136, 141, 161, 201, 205, 221, 242, 359, 419, 421, 439

ELECTRIC LIGHTING (*continued*):—
in Paris Theatres, 2
in Paris, Uniforms for Electricians, 181
on H.M.S. "Pelican," 21
in the Persian Bank, Austinfriars, 321
in Philadelphia, 82
for Plymouth, 182
in Poland, 141
in Portland (U.S.), 42
for Portsmouth, 1
for Preston, 439
for Printing Offices, 201
Prodigality in Economy, C. C. Haskins, 253, 271
Profits in America, 2
Provisional Orders Abandoned, 42
Provisional Orders, Applications for, 181
Provisional Orders, Consent of Local Authorities, 183, 261
Provisional Orders and Local Authorities, 1, 2, 3, 4, 21, 23, 24, 25, 41, 42, 43, 61, 62, 63, 64, 81, 82, 83, 84, 90, 101, 102, 122, 123, 125, 143, 161, 182, 184, 203, 222, 232, 250, 262, 263, 264, 279, 282, 300, 301, 326, 339, 340, 360, 379, 380, 400, 440, 459, 479, 502 (*see* Model Orders)
Provisional Orders, Objections to, 1
and Public Lighting, 82
Public Lighting, H. A. Mavor, 243
in the Public Record Office, 62
of Railway Carriages, Automatic, 2
in Reading, 82, 204, 282
of Reading Free Library, 63
in Reichenhall (Bavaria), 379
for Richmond (Surrey), 62, 82
for Rochester, 61, 81, 479
for Rotterdam, 261
and St. George's (Hanover-square) Vestry, 122, 380
and St. James's Vestry, 301
at St. Ouen-les-Docks, 205
in St. Pancras, 25, 123, 204, 441
in Saint Sebastien, 161
Safety of, Sir W. Thomson, 184
Safety Devices, E. Thomson, 234, 252
Salomon's Book on, 91
in Salonica, 1
in Salzburg, 23
and San Francisco Fire Brigade, 121
at San Maritz, 201
for Santa Cruz, Teneriff, 281
Sardinia-street Station, Explosion at, 82
in Savoy Chapel and Schools, 319
for Scarborough, 63, 124, 300
in Schirmeck, 479
Search-Lights at San Francisco, 263
in Sens (France), 241
at Sétif (France), 379
for Sevenoaks, 161
in Shanghai, 121
for Sheffield, 459
on Ships, 21, 43, 62, 101, 103, 121, 163, 185, 303, 328, 332, 340, 350, 420
in Siam, 221
in Smyrna, 221
for Sofia, 379
in Somerville (U.S.A.), 81
for Southampton, 42, 399
in Spain, 62, 281
for Stockport, 21
for Stockton, 459
for the Strand, 123
of Strasburg Cathedral, 201
and Street Railways in Richmond (Virginia), 439
for Sunderland, 264, 339, 379
Supply of and the Legislature, Major Cardew, 414, 434, 454
for Sutton, Southcoates, etc., 103
for Swansea, 21, 202, 500
in Switzerland, 102, 141
in Sydney *Daily Telegraph* Offices, 20
in Taunton, 125, 137, 241, 303, 329
Tenders Invited for, 21, 102, 103, 104, 281, 339, 440, 441
in Tennessee, 339
in Theatres, 2, 103, 379, 419, 441, 479, 500
Theatrical Fairy Lamps, 103
Three-Wire System, 122
at Tithebarne Station, Liverpool, 399
for Tittmarning, 479
in Tiverton, 2
for Torquay, 25, 319
at Toulouse, 48
of Trains, 61
in Troyes, 499
at Madame Tussaud's, 380
on the "Tyrian," 62
Urquhart's Book on, 77
in Vienna, 122

ELECTRIC LIGHTING (*continued*) :—
  for Walthamstow, 1
  for Wandsworth, 63, 300
  in Waterford, 329
  at Wazemmes Railway Station, 141
  Westinghouse Stations, 163
  in Westminster, 123, 323, 340
  in Weybridge, 223, 329, 482
  by Means of the Weymersch Battery, 321
  in Wiener-Neustadt Brewery, 3
  for Windsor, 499
  Wires, Flexible Mouldings for, 285
  in Woking, 44, 439, 459, 500
  in Wolverhampton, 420
  Work of the Year, 12, 30, 77
  for Wrexham, 360, 380, 459
  in Ziskow, Prague, 419
Electric Flashes, S. P. Thompson, 99
Electric Steering Gear, 400
Electric Supply, Major Cardew, 414, 434, 454
Electric Traction Company's System, 21, 83
Electric Traction and Electric Construction Companies, 262
ELECTRIC TRACTION : Advance of, 261 ; A Challenge, 50 ; Consolidation of Firms, 221 ; *Daily News* on, 58 ; Darling's Locomotive, 171 ; Data, A. Reckenzaun, 364 ; Formation of General Company, 428 ; *v.* Horses, 399 ; "More Companies," 469 ; in Paris, 459 ; a Rival, 205 ; in Russia, 141 ; and the South London Trams, 201 ; and Steam, 1 ; Wanted a Word, 282, 290, 301
Electrical Action, H. B. Carhart, 18, 38
Electrical Activity, 162
Electrical Bureau at Guadaljara, 21
Electrical Club, Proposed, 283
Electrical Engineer (N.Y.), Editorial Changes, 241, 264, 300
Electrical Engineer, A Plea for, 286, 307
Electrical Engineering for Artisans, 310
Electrical Engineer's Amenities, 448
Electrical Engineers, Appointments for Cities, 81
ELECTRICAL ENGINEERS, INSTITUTION OF : Cardew, Electric Supply, 414, 434, 454 ; Conversazione, 480 ; Council Report, 105 ; Demonstration of Electric Welding at, 342 ; and Edinburgh Exhibition, A Suggestion, 429, 501 ; Esson, Dynamo Design, 172, 194, 214, 237, 248 ; Higgins, Diathermancy of Air in Relation to Efficiency of Incandescent Lamps, 306 ; Lawrence and Harries, Electric Currents and the Human Body, 276 ; Lodge, Lightning Guards, 391, 409, 425, 452 ; President's Address, J. Hopkinson, 27, 52, 94 ; Salomons Scholarship, 182 ; Swinburne, Armature Reactions, 132, 152, 168, 237, 248
Electrical Engineers, Training of, 31
Electrical Engineering Company of Ireland, 205, 220
Electrical Engineering Corporation, Meetings, etc., 44, 140 ; their Switch, 108
Electrical Engineering, First Principles of, 85, 108
Electrical Forces, Prof. Rücker on, 118
Electrical Phenomena in Nature, 124
Electrical Pressure, How to Produce it, 126, 146, 226, 246
"Electrical Reports," Whipple's, 339
Electrical Review (New York), 1
Electrical Supply Company of Chicago, 42
Electrical Theories, W. A. Anthony, 198, 207
Electrical World, Editorial Changes, 241, 264
Electrician, The Passionate, 301
Electricians in Paris, Uniforms for, 181
ELECTRICITY : On Board Warships, 143 ; Chemical Generation of, 500 ; in the Dairy, 82 ; Dangers of, 5, 11, 17, 30 ; Direct from Coal, 183 ; in Engineering Workshops, 342 ; Execution by, 261, 339, 361, 459 ; Increasing Traction by, 483 ; and Magnetism, Lord Rayleigh, 142 ; in Our Homes, 181 ; The Most Important Discovery, 242 ; Revolutionised, 420 ; and Steam in Transportation, 420 ; O. T. Crosby, 471, 493, 512 ; its Uses in the House, 262
Electricity Supply Company, Abandonment of Orders, 42
Electrodes, Polarisation of, 481
Electrodynamic Law, Weber's, 359
Electro-Harmonic Society, 79, 143, 224, 359
Electrolin, 301, 359
Electromagnet, the, Cantor Lectures on, 43, 110
Electromagnets, Diminutive, 282
Electrometer, Moseley's Pocket, 288
Electromotive Force, Constant, with Variable Speed, 114
Electroplating, Variable, 359
Electro-Therapeutics, 101
Elieson *v.* Crompton, 439, 468, 475
Elliott's Smoke Annihilator, 502
Elliott's Wood Casings, 101
Elmore's Wire Company, 222
Enamel Shades, 202
Enamelled Iron, 439
Engineers' Certificates, 262
Engines, New, for Dynamo Driving on Warships, 224
Engineering Workshops, Electricity in, 342
E.P.S. Cells for Traction Work, 381
Esson, W. B., Dynamo Design, 172, 194, 214, 237, 248
Ether Theory of 1839, 109, 171
Exhibition at Lenox Lyceum, New York, 321
Explosion at Sardinia-street Station, 82
Explosive Mixtures and Incandescent Lamps, 399
Eye Magnet, 499

F.

Fahrig's Ozone Process, 281, 323
Fairgrieve's Exhibit at Edinburgh, 490
Fairy Lamps, Theatrical, 103
Fan Outfits, 479
Far-seeing Machine, Edison's, 419
Far West Telegraphs, 21
Faraday's Artistic Fittings, 142
Fareham Electric Light Company, 43
Fawcus and Cowan, Keswick Station, 407
Ferranti Mains, 89, 121, 301, 302, 340, 361, 381, 484, 488, 499
Ferranti Staff's Smoking Concert, 242
Field, C. J., Generating Stations, 266
Filaments, Spiral, 181
Fire Alarms, 161
Fire Brigade Lanterns, 121
Firedamp Exploded by an Incandescent Lamp, 399
Fire Dangers, 150, 157
Fire Engine of the Future, 480
Fires from Electricity, 5, 11, 17, 181, 283, 499
Fitting for Electric Lamps, The Combination, 178
FITTINGS, ARTISTIC : Faraday's, 142 ; General Electric Company's, 182 ; Lea's, 42 ; Osler's, 142 ; Verity's, 4
Flash Signalling, Scott's Lantern, 424
Flashing Signals, The Inventor of, 400
Fleming, J. A., Prof. Thomson's Experiments, 411, 431, 450, 474, 479
Fog Lights for Ships, 303
Fog Signal at Bell Rock, 163
Fog Signals for Vessels, 263
Foord, E. J., Mining and Electricity, 212
Forbes, G., Physiological Effects of Currents, 269
Forth Bridge and Telegraph Wires, 123
Fountains, Luminous, 64
Fowler's Hammering and Welding Machine, 211
Frankfort Commission on Electric Lighting, 292, 312, 330
Frankfort Exhibition, 41, 61, 261, 401, 463
Frankland, Dr., Technical Education, 383
Franklin, Centennial of his Death, 359 ; a Precursor to, 400
Fraud, A, 379, 399
French Academy of Sciences, 299
French Dividends, 1
French Electrician, Plot to Assassinate a, 400
French Electric Finance, 499
French Exhibition, 221, 241, 299
French Post Office, 81
Frischen, C., Death of, 401
Fritsche's Dynamo, 261
Fuses, Scott's Instantaneous, 7

G.

Galvanometers, Ayrton, Mather, and Sumpner, 99, 106, 137
Galvanometers, Scales for, A. P. Trotter, 179
Ganz's Alternate Motor, 272, 302
Ganz's Patents in France, 339
Ganz and Co. *v.* Gaulard and Gibbs, 121
Gas in America, 81
Gas and Electric Lighting, 48, 61, 81, 82, 121, 161, 182, 230, 265, 331, 341, 399, 440, 459, 481, 499
Gas Pipes and Lightning, 101
Gas Purification, Graham's Method, 61
Gasman, The, Saved, 23
Gas Works Supplying Electricity, 459
Gatti's Central Station, 63, 82, 123, 499
Gearing, Raw Hide, 299
General Electric Traction Company, 428, 462, 467
GENERAL ELECTRIC COMPANY : Cards Issued by, 41 ; their Fittings, 182 ; Work of the Year, 32
Generating Stations, C. J. Field, 266
Gent and Co., Dissolution of Partnership, 42
Gerard's Lamp, 419
German Telegraphs, 399
Germany and Electric Tram Lines, 101
Gifts, Electrical, 82
Gilt Edge, Short-circuited by, 481
Glasgow Central Railway, 442
Glasgow Philosophical Society, 243
Glasgow Students' Bazaar, 61
Globe Lighting in a Central Station, 143
Globe Telegraph Company, Meetings, 40, 260
Glover and Co.'s Exhibits at Edinburgh, 466
Gold Mining, Edison and, 380
Goolden and Ravenshaw's Dynamo Regulators, 446
Gordon, J. E. H., and Electrical Activity, 162
Governments and Patronage, 70
Government Telegrams, 164
Grapnel, Benest's, 347
Great Western Railway at Edinburgh Exhibition, 503
Gulcher Company, Resignation of Mr. Binswanger, 222
Guinand, F., Helvetia Dynamo, 404
Guttapercha, Artificial, 341, 362
Guttapercha, Supply of, 359
Gramme's Arc Lamp, 34

H.

Halifax-Bermuda Cable, 402, 479, 499
Halske, J. G., Death of, 242
Hammond College, The, 1, 24
Haskins, C. C., Prodigality in Economy, 253, 271
Hastings Electric Light Company, Meetings, etc., 420
Hawes, F. B., Carbon Deposit in Telephone Transmitter, 179
Headlights for Locomotives, 263
Heat Cells Problem, 505
Heater, Burton's Electric, 319
Heating Effects of Currents, W. H. Preece, 384
Heating, Electric, 439
Hedges, K., Electric Lighting in Brighton, 213
Helvetia Dynamo, F. Guinand, 404
Henry's Motor, 360
Heriot-Watt College, 189
Herz, Dr. C., Plot Against, 400
Holmes and Co.'s Works, Addition to, 339
Holst, J. M., Death of, 21
Hookham's Meter, Tests at Liverpool, 299
Hopkinson, J., Address on Magnetism to Electrical Engineers, 27, 52, 94
Hopkinson's Patents, 459
Hoskier's Book on Testing, 2, 132
Hospitalier, E., his Book on Electric Energy, 77
House-to-House Electric Supply Company, Meetings, etc., 356, 376 ; their Lighting Bill, 62
Houses and the Applications of Electricity, 262
Howard, F. G., his Business, 440
Hughens Gearing, Lord Rayleigh, 456
Hughes, Prof. D. E., Portrait and Notice of, 6
Hughes and Lancaster's Compressed Air Tram, 205
Hutchinson, C. L., Tramway Data, 350, 390
Human Body and Electric Currents, 269, 276, 289
Hydraulic Power Company's Motors, 439
Hydro-Electric Cable Railway, Berlier's, 203

I.

Ignario, a Precursor to Franklin, 400
Imchenetzki's Battery, 143
Impostor, An, 379, 399
INCANDESCENT LAMPS : Backstrom's, 241 ; Bernstein's, 281 ; for Buoys, 84 ; Cost of Lighting by, 303 ; Data of, W. L. Puffer, 72 ; Davis and Son's Holder for, 310 ; Diathermancy of Air in Relation to Efficiency of, F. Higgins, 306 ; Edison Patent in Germany, 460 ; an Electric Candle, 122 ; Expanding Guard for, 261 ; and Explosive Mixtures, 399 ; Gérard's, 419 ; as Hat Irons, 22 ; Lane Fox Patents, 368, 389, 449, 469, 489, 506 ; Langhan's, 244, 261, 345 ; Large *v.* Arc Lamps, S. F. Walker, 6 ; Life of, 104, 441 ; for Mines, Coad's, 89, 131, 149, 172, 191 ;

Moss covered, 62; New, Half a watt per Candle, 222; for Signalling at Sea, 162, 211; Spiral Filaments for, 181; and Spiritualists, 479; Tinting Bulbs, 203; without a Vacuum, 121
India Rubber Company, Meetings, etc., 139, 159; their Dry Cell, 302
Indiarubber, The Brazilian, Trade, 64
Indian Telegraphs, 21, 241, 419, 439
Indian Tramways, 221
Indo-European Company, Meetings, 318, 356
Induction, Self, Unit of, 379
Insurance in America, Mutual Electric, 122
Insurance of Electric Light Employés, 419
Inverse Squares, 130, 151
Investment Company, Electric, 401
Iron Batteries, Jablochkoff's, 101
Iron, Villari Critical Points in, 249, 476

J.

Japan, Exhibition in, 281
Johannesburg, Electricity at, 162
Johnson and Phillips, Work of the Year, 14
Johnstone, J., Ether Theory of 1839, 109, 171
Johnstone, J., More Light on Electricity, 289
Jones and Hall's Voltmeters, 189
Joule Memorial, International, 65, 161
Joule's Scientific Work, 87
Jubilee of the Penny Post, 262

K.

Kapp, G., Aron's Meter, 115; Field-Magnet Coils, 287
Kensington Company's Map, 141
Keswick Station, Fawcus and Cowan, 407
Kew Magnet, Variations of, 477
Kibblesworth Colliery, Thunderstorm at, 422
King, Mendham, and Co.'s Exhibits at Edinburgh, 466
King's College—Evening Classes, 460; Siemens Laboratory at, 379
Kirchoff, Prof., Death of, 299
Knight's Oil Engine, 262
Kœnig's Researches, S. P. Thompson, 456

L.

Laboratories, The Fitting up of, 423
Labour Disputes, Their Adjustment, 135
Lamp Guard, Expanding, 261
Lampholders, Davis and Sons, 310
Lane Fox Patents, 368, 389, 449, 469, 489, 506
Langhans Incandescent Lamp, 244, 261, 345
Launches, Electric, 242, 243, 261, 284, 419, 499
Laurence, Paris, and Scott, The Work of the Year, 14
Laurent Cely Accumulators, 360, 502
Law, M. D., Nine Years with the Arc Lamp, 227
Lawrence and Harries, Electric Currents and the Human Body, 269, 276, 289
Lawyers, Good for the, 408
Lea, F. B., and *Electric Plant*, 439
Lea Bridge Tramway Company, A Challenge, 50
Lea's Floral Fittings, 42
Leading Articles: Americans in Convention, 190; Bad Workmanship, 150; Brighton Accident, 251; Cardiff, An Ancient Tale, 51; Challenge, A (Electrical Traction), 50; Chelmsford, 308; Crompton *v.* Elieson, 468; Deptford, 488; Electrical Engineers' Amenities, 448; Electric Traction (General Company), 428; Electromagnet, The, 110; Good for the Lawyers, 408; Governments and Patronage, 70; Ho! for the Schoolmaster, 270; Inverse Squares, 130; Lane Fox Patents, 368, 506; Local Authorities, 90, 250; Maxim-Weston, 388; The Model Orders, 348; More Traction Companies, 469; Natural Order of Things, 230; Paris Congress, 388; Patent Matters, 506; Pressure *v.* Potential, 309; Price per Unit, 329; Prospective and Retrospective, 10, 30, 77; Ship Lighting, 328; A Suggestion: Cable Pioneers, 70; A Suggestion: The Institution and the Edinburgh Exhibition, 429; Theory, A, 170; "Too Soon," Local Authorities and Electric Lighting, 349; Trade, The, and the Public, 210; Wanted, a Word, 290
Leçons sur l'Electricité, H. Pellatt, 132
Leeds Exhibition, 436, 441
Lectures, University Extension, 121, 261
Legal: Bell's Telephone Patents, 161; Brighton Accident, 251, 258; Brush *v.* Julien, 300; Causton *v.* National Telephone Company, 396; Cowles *v.* Herault, 339; Edison *v.* Naglo, 460; Elieson *v.* Crompton, 439, 468, 475; Ganz and Co. *v.* Gaulard and Gibbs, 121; Reece *v.* Latimer Clark, 417; Swan *v.* German Edison Company, 379
Leipzig Exhibition, 61
Lever, Charles, Death of, 22
Leyden Jar Experiments, J. Johnstone, 289
Liege, Exhibition, 141
Lifeboat Stations and the Telegraph, 2
Lightning: Accidents from, S. Bidwell, 124; and Colliery Ropes, 105, 422; at Cranleigh, Capt. Maclear, 481; and Gaspipes, 101; Globe, in a Central Station, 143; Guards, O. J. Lodge, 391, 409, 425, 452; in a Watchmaker's Shop, 399; Zigzag Flashes, 142
Lineff's Tram System, 504
Literature: Hoskier, V., Testing Cables, 2, 132; Hospitalier, E., Electric Energy, 77; Lawrence, H N., Medical Electricity, 142; Lukin, J., Turning Lathes, 102; Pellatt, H., Leçons sur l'Electricité, 132; Salomons, Sir D., Installations and Accumulators, 91; Slingo and Brooker, Electrical Engineering for Artisans, 310; Urquhart, J. W., Electric Light, 77
Lithanode, 144
Liverpool Engineering Society, 243
Liverpool Physical Society, 63
Lloyds and Ship Lighting, 328, 332
Local Authorities: and the Board of Trade, 342, 375; and Electric Lighting, "Too Soon," 349; *v.* Supply Companies, 250, 261, 341, 375
Locomotives, Electric: Article on, 491; Darlings, 171; Immisch's, 479; Thomson-Houston's, 399
Locomotive Headlights, 263
Lodge, O. J., Lightning Guards, 391, 409, 425, 452
Lodge's Lightning Guard at Edinburgh, 399
London Chamber of Commerce, 88, 90, 135, 319, 482, 499
London County Council: Appointments, 142; and Electric Lighting, 285; Lighting Inspector, 61; its Money Bill, 202; and Provisional Orders, 84; Testing Station, 285; its Wire Bill, 62, 141, 181, 201, 202, 299, 339, 361, 462, 479
London Electric Corporation: Chairmanship of, 161; its Mains, 89, 121, 301, 302, 340, 361, 381; Meetings, etc., 279
London, Main Laying in, 361, 399
London Tramways and Electricity, 58, 82
Lubricator, New, Dynamine, 283
Lukin, J., Turning-Lathes, 102

M.

Macdonald's Exhibit at Edinburgh, 503
Machinery, Defective, Action Against L. Clark, 417
Machinery, The Rating of, 302, 359
Mackay's Cables, 281
Madrid, Electrical School in, 201
Magdeburg Testing Station, 480
Magnetic Needle in the Dark Ages, 112
Magnetic Separators, 399, 499
Magnetic Survey of the United Kingdom, 335
Magnetism, Dr. Hopkinson's Address on, 27, 52, 94
Magnetism, Permanent, M. Osmond, 335
Manchester Chemical Exhibition, 323
Manchester Edison-Swan Company, Work of the Year, 32
Mansfield, The Lighting of, 201
Marshall, N., Westinghouse Converters, 85
Mather and Platt's Alternate Dynamo, 69
Mather, T., Movable Coils in Meters, 249
Mats, Electric, 1
Maxim-Weston Company: Its History, 388; Meetings, etc., 397; Progress of, 163
Mayfield and Co., Meetings, etc., 100
Mayor, The Lord, His Electric Coach, 439, 501
Medical Electricity, 121, 142
Medical Electricity, Institute of, 359
Medical Lantern, Stricker's, 300, 325
Megaphone, The, 319
Men, Good, in Demand, 202
Mercier, Corlett, and Co., 202
Metallurgy, Electric, 512
Meters, Electric: Aron's, 115, 183; Hookham's, 299; Jones and Hall's, 189; Paris Competition 141 182 222; Reckenzaun's, 181; Shallenberger's, 61, 321; Shape of Movable Coils in, 7; Mather, 249
Meteorological Exhibition, 102
Meteorological Society, Royal, 481
Metropolitan Fire Brigade, New Station, 241
Metropolitan Supply Company: Its Mains, 340; The *Stock Exchange* on, 224
Mexico, Telegraph and Telephone in, 379
Meyland's Dry Battery, 479
Mica, Moulded, 181
Microscope, Electric Lanterns, Stricker's, 300, 325
Miner's Lamp, Coad's, 89, 131, 149, 172, 191
Mining, Electric, 221, 244, 380
Mining and Electricity, E. J. Foord, 219
Mining Engineers, Institution of, 22
Mining Exhibition at Crystal Palace, 61, 164
Minneapolis Power Supply Station, 241, 262
Mix and Genest in London, 480
Mix and Genest's Telephone, 313
Model Orders, The, 348, 352, 361, 374, 394, 416, 436
Molecular Telephone, The, 319
Money Orders, Telegraphing, 141
Montevideo Lighting, 460
Montevideo Telephone Company, Meetings, etc., 318
Moon, J. G., Presentation to, 222
Morphia, Death from, 21
Morgan's Police Signal System, 225
Moseley's Pocket Electrometer, 288
Moss Covered Lamps, 62
Motor, Steam, the Bailey-Friedrich, 149
Motor, A Sulphuric Ether, 379
Motors, Electric: for Advertising, 380; Alternate, 182, 299, 360; C. & C., 331, 403; at the Comstock Mine, 244; Cuttriss's, 479; Daft's, 439; Edison Company of Boston, their Example, 81; for Fan Driving, 479; Ganz's, 272, 302; High Tension Currents for, E. A. Sperry, 155; Hydraulic Company, 439; Jones's Overbalanced Wheel, 420; for Mining, 124, 221, 419; Mordey's, 382; New, 302; in a Play, 221; for Printing, 101, 143; for Pumping, 320; in Railway Work, Dr. L. Bell, 273, 297, 317; and Seed Cleaning, 121; Series at Edinburgh Exhibition, 322; for Sewing Machine, 181; for Sleighs, 121; Sprague's 141, 213, 464; Swinburne's, 256, 302; Tesla's, 16, 124, 419; Thomson-Houston, 165; for Warships, 143; without Fields, Henry's, 360
Mouldings, Flexible, 285
Municipal Corporations and Board of Trade, 232, 261, 311

N.

National Electric Light Association (U.S.A.): Haskins, C. C., Prodigality in Economy, 253, 271; Law, M. D., Nine Years with the Arc Lamp, 227; Leading Article on, 190; Sprague, F. J., Street Railways, 193; Thomson, E., Safety Devices, 234, 252
National Telephone Company and Causton, 396
Natural Order of Things, The, 230
Naval Construction, 224
Navy Fittings, Standard, 101
Newcastle Electric Lighting Company, Meeting, etc., 259
New Guinea, Astonishing the Natives, 202
New York: Board of Control Report, 116; Conduits, 441; Electric Club, 387; Exhibition at Lenox Lyceum, 321; Harbour Buoys, 419; Notes from, 48; Subways and Westinghouse, 161
New Zealand Cable, New, 379; Exhibition, 61
Niagara Falls, Utilisation of, 201, 301
Nickel, Villari Critical Points in, 249, 476
Nile, Steam Navigation on, 43
Northampton Electric Light Company, Meetings, etc., 477
North Metropolitan Tramways and Electric Traction, 21, 83, 104, 262, 419, 440, 459
North Sea Cables, 480
Notting Hill Electric Light Company, Meetings, etc., 42, 180
Nova Scotia-New York Cables, 82

O.

Obituary Notices: Cowles, A., 41; Despointes, F., 23; De Tornos, Don, 43; Frischen, C., 401; Halske, J. G., 242; Holst, J. M., 21; Lever, Charles, 22; Snell, W. H., 211
Oerlikon Works, Enlargement of, 61

Oetzmann's Variable Electroplating, 359
Offor, G., Local Authorities and Electric Lighting, 179
Oil Engine, Knight's, 262
Omnibuses, Electric, 184, 322, 359, 439, 442, 459, 501
Ore Reducer, Edison's, 380
Oriental Telephone Company, Meetings, etc., 298, 337, 356
Osmond, M., Permanent Magnetism, 335
Oxidising Wires, 202
Ozone, Fahrig's Process, 281, 323
Ozone Room Purifiers, 482

P.

Page, S. Flood, Fire Dangers, 157
Palmieri and Weather Prediction, 94
PARIS: Academy of Sciences, Prizes Awarded by, 61; Burglar Catching in, 400; Compressed Air in, 2; Congress (*see* TELEGRAPHIC CONGRESS); Electrical Laboratory for, 183; Exhibition, 142, 281; The Lighting of, 421; Meter Competition, 141, 182, 222; Metropolitan Railway for, 319
Parisian Electricians, 181
Partnership, Dissolution of, 42
Passionate, Electrician, The, 301
Patent Matters, 506
Patents, List of, 40, 68, 80, 100, 120, 140, 160, 180, 200, 220, 240, 260, 280, 318, 338, 358, 378, 398, 418, 438, 458, 478, 498, 514
Paterson and Cooper, The Work of the Year, 14; their Catalogue, 224
Pellat, H., Leçons sur l'Electricité, 132
Perreur-Lloyd Process, 264
Permanent Magnetism, M. Osmond, 335
Personal, 1, 41, 121, 161, 221, 261, 419, 439
Pfluger's Accumulator Switch, 430
Phosphor Bronze Company, The Work of the Year, 14
Photographic Flash Lamp, 111
Photographing Underground, 442
Photos of Moving Objects, C. V. Boys, 476
PHYSICAL SOCIETY: Ayrton, Mather, and Sumpner, Galvanometers, 99, 106, 137; Boys, The Oscillating Spark, 476; Photos of Moving Objects, 476; Hawes, F. B., Carbon Deposit in Telephone Transmitter, 179; Mather, T., Movable Coils, 249; Osmond, Permanent Magnetism, 335; Rayleigh, Hughens Gearing, 457; Report of Council, 137; Robson and Smith, Diurnal Variations of Kew Magnet, 477; Rücker, Magnetic Survey, 335; Thompson, S. P., Electric Splashes, 99; Kœnig's Researches, 456; Tomlinson, H., Villari Critical Points in Iron and Nickel, 249, 476; Trotter, A. P., Recording Instruments, 179; Scales for Galvanometers, 179.
Physiological Effects of Currents, 269, 276, 289
Pioneers, Cable, A Suggestion, 71
Pittsburgh Busy, 281
Platinum, 440
Platinum Salts, Electrolysis of, A. Watt, 166, 186, 206
Pocket Information, 41
Police Signals, Morgan's, 225
Ponies, Electric, 35
Poole and White, Messrs., 22
Popp's System in Germany, 83, 181, 241, 281, 319
Portable Lamp, Rénard's, 463
Portsmouth, New Dynamo Engines, 224
Post Office Exhibit at Edinburgh, 404
Postal Jubilee, 262
Postal Telegraph Service, 161, 164
Potential, Constant, with Over-Compounded Dynamos, A. Dow, 304
POWER STATIONS: At Boston (U.S.), 161; in Newark (U.S.), 439; To Let, 282; near Minneapolis, 241, 262
Power Transmission, at Bourgeneuf, 145; at Heilbronn, 482; in Italy, 61; in Switzerland, 61, 221, 419
Preece, W. H., Heating Effects of Currents, 384
Pressure, Electrical, How to Produce it, 126, 146, 226, 246
Pressure *v.* Potential, 309
Printing by Electricity, 101, 143
Printing Telegraph, The Column, 462, 479
Prizes Offered by the Société d'Encouragement, 282
Prospective and Retrospective, 10, 30
PROVISIONAL ORDERS: Abandoned, 42; Applications for in 1890, 181; Consent of Local Authorities, 183, 311; and Local Authorities, 1, 2, 3, 4, 21, 23, 24, 25, 41, 42, 43, 61, 62, 63, 64, 81, 82, 83, 84, 90, 101, 102, 122, 123, 125, 142, 161, 182, 184, 203, 222, 232, 250, 261, 262, 263, 264, 279, 282, 300, 301, 326, 339, 340, 360, 379, 380, 400, 440, 459, 479, 502; The Model, 348, 352, 361, 374, 394, 416, 436; Objections to, 1 (*see also* Model Orders)
Public, The, and the Trade, 210
Public Lighting, 82
Puffer, W. L., Plots of Incandescent Lamps, 72
Pulleys, Belts, and Shafting, 46, 66
Pulleys: Paper, 162; Leather Covered, 41; Tomlinson and Walker's, 181
Punkah-pulling, Mechanical, 23

R.

Rail Scraper, 82
Railroad Telegraph, New, 161
Railway Carriage Lighting, Automatic, 2
Railway Signals, Distant, Control of, 461
RAILWAYS ELECTRIC (*see also* TRAMWAYS): in America, 500; to Archangel, 222, 319; between Atlanta and Savannah, 103; at Baden, 281; Berlier's Hydro-Electric-Cable, 203; at Boston (U.S.) 41, 299, 439; at Buda-Pesth, Accident on, 321; at Burgenstock 184; Central London, 8, 62, 81, 141, 221, 322, 343, 359, 362, 380, 419, 461; Conduit System without Slots, 124; by O. T. Crosby, 471, 493; at Edinburgh Exhibition, 64; at Elberfeld, 61; and Electric Lighting in Richmond (Virginia), 439; for Glasgow, 442; in Japan, 141; between Long Island and Brooklyn, 459; in Mexico, 479; and Motors, Dr. L. Bell, 273, 297, 317; between Orange and Athol (Mass.), 440; Passengers Carried by, 299; at Pittston, 241; Raw Hide Gearing for, 299; a Rival, 205; in Rome, 319; in Russia, 141; in St. Louis, 41, 459; Series Traction Company's Work, 62; Southwark, 104, 160, 185, 203, 221, 262, 481; by F. J. Sprague, 192; Sprague's in America, 262, 319; Subway for London, 3 (*see also* CENTRAL AND SOUTHWARK); at Trefriw (Wales), 2; Trials on the District Line, 321; Volk's at Brighton, 162, 203; Weems Express, 359; Wetzler on, 284
Randall, C. A., his Exhibit at Edinburgh, 490
Ransomes, Sims, and Jefferies: Award to, 379; Work of the Year, 14
Rapid Telegraphy, 24
Rathbone, R. L. B., Work of the Year, 32
Rayleigh, Lord: Electricity and Magnetism, 142; Hughens Gearing, 456; Elected Member of French Academy, 299
Readers, To Haul, 450
Rechniewski's Dynamo, 234
Reckenzaun, A., Electric Traction Data, 364; His Meter, 181
Recording Instruments, A. P. Trotter, 179
Red Tape at New York, 419
Reece *v.* Latimer Clark, 417
Refining, Electrical, 399
Reignier and Bary's Dynamos, 251, 344
Rénard's Portable Lamp, 463
Resistance of Batteries, 322
Resistance Frames, 163
Reuter's Telegram Company, Meetings, etc., 337
Review of the Year, 10, 30, 77, 94
Reynier's Accumulators, 480
Rhine, Utilisation of, 299
Robey and Co., Award to, 121; their Electric Light Engine, 9
Rope Gearing, 201
Ross, Courtney, and Co., 299
Roundabout, An Electric, 301
Royal Albert Docks, Blowing up Wall of, 441
Royal Institution, The, 1, 121, 142
Royal Society's Conversazione, 481
Rubber Belts, Seamless, 41
Rücker, Prof., on Electrical Forces, 118; Magnetic Survey of the United Kingdom, 335
Ruston, Proctor, and Co., Award to, 1, 81
Ryan, H. J., Transformers, 35, 57, 76
Rysselberghe and the Brussels Municipality, 2, 62
Rysselberghe's System in Austria, 122

S.

Safety Devices, E. Thomson, 234, 252
St. Pancras Vestry and Dr. Hopkinson, 123
Sale of Plant, 379
Salomons, Sir D., Scholarship Founded by, 182; Installations and Accumulators, 91
Saunderson's Arc Light, 386
Schanschieff Battery Company, 21, 223
School of Electrical Engineering, Work of the Year, 33
Schools, Electrical, and their Training, 31
Schoolmaster, Ho! for the, 270
Scotland Electric Lighting Bill, 459
Scot's Magazine at Edinburgh Exhibition, 404
Scott and Co., E., The Work of the Year, 14
Scott and Co.'s Exhibit at Edinburgh, 444
Scott's Flash Signalling Lantern, 424
Scott's Instantaneous Fuses, 7
Search-Lights for Military Operations, 101
Search-Lights at San Francisco, 263
Seed Cleaning and Motors, 121
Seeing Machine, Edison's Long Distance, 419
Seeing's Believing, 462
Self-Induction, Unit of, 379
Separators, Magnetic, 399
Series Traction Company's Work, 62
Sewage Purification, Webster's Process, 164
Shafting, Compressed Wrought, 183
Shallenberger's Meter, 61, 321
Ship Lighting, 21, 43, 62, 101, 103, 121, 163, 185, 303, 328, 332, 340, 350, 420
Shippey Bros.: Appointed Agents to Viaduct Company, 340; Award to, 161
Ships' Fog Signals, 263
Ships, Steel, and Compasses, 263
Ships of War and Electricity, 143
Short-circuited by a Gilt Edge, 481
Short's Steel Railway System, 301
Siam, 221
Sidewalks, Travelling, 63
Siemens, Dr. W., Retirement of, 221
SIEMENS: Laboratory at King's College, 379; New Cable Works, 141; Visit to Berlin Works, 281
Signalling Lantern, Scott's, 424
Signalling Apparatus, Dr. Marzari's, 319
Signalling at Sea, 162, 211
Signals, Distant, Control of, 461
Silcock, E. J., Award to, 1
Silvertown Dry Cell, 302
Sleigh Driving by Electricity, 121
Sliding Railway, The, 222
Smoke Annihilator, Elliott's 502
Snell, W. H., Obituary Notice of, 211
Snow Ploughs, Electric, 81, 221
Société d'Eclairage Electrique, 1
Solar Action on Electric Charges, 222
Soldering, Electric, 459
South London Mains, 361
Southwark Subway, 104, 160, 185, 203, 221 262, 481
Spain and Cuba, Cable for, 399
Spain, Electrical Bureau at Guadaljara, 21
Spain, Electrotechnology in, 201
Spark, Electric, The Oscillating, 476
Sparks, C. P., Marriage of, 299; Presentation to, 242
Sperry, E. A., High-Tension Currents for Motors, 155
Splashes, Electric, S. P. Thompson, 99
SPRAGUE, F. J.: His Electric Railways, 262, 319; his Motor, Magnetic Data of, 464; 75 h.p. Motor, 213; on Street Railways, 192
Square Hole Drill, 340
Standardising and Training Institution, 1, 24
Staples, Insulating, 161
Statter and Co.'s Work of the Year, 94
Statter's Constant Current Dynamos, 101
Steam *v.* Electric Traction, 1
Steam and Electricity in Transportation, O. T. Crosby, 471, 493, 512
Steam Motor, The Bailey-Friedrich, 149
Steamers' Tail Shafts, Coppering, 123
Steering Gear, Electric, 400
Street Railways (*see* TRAMWAYS)
Street Traction, Rosenbusch's Scheme, 400
Streets, Obscure, 282
Stricker's Medical Lantern, 300, 325
Submarine Cables Trust, Meetings, etc., 358, 378
Submarine Telegraph Co., Meetings, etc., 317
Submarine Telegraph History, 71
Subway Railways for London, 3 (*see also* RAILWAYS, ELECTRIC).
Subways in New York, Report on, 116
Sugar, Electric, Refining Swindle, 359
Suggestion, A, 429
Sulphuric Ether Motor, A, 379
Sunbeam Lamp *v.* Arc Lamps, 6
Swan *v.* German Edison Company, 379
Swan United Company, Meetings, etc., 358
Swinburne, J., Armature Reactions, 132, 152, 168, 237, 249
Swinburne's Alternate Motor, 256

SWITCHES : Cockburn's Double-Pole, 109, 111 ; Electrical Engineering Corporation's, 108 ; Dorman and Smith's, 359 ; Poole and White's, 181 ; Woodhouse and Rawson's Double-Pole, 89, 111

T.

Tanning, Electric, British Company's Process, 382
Tatham's Conduit, 123
Taunton Electric Light Company, Meetings, etc., 137
Technical Education, Dr. Frankland, 383
Telautograph, an English Invention, 383
Telegrams, Reply-paid, 161
Telegrams forwarded by Telephone, 319
Telegraph Construction Company, Meetings, etc., 140, 180, 199
Telegraph Manufacturing Company, their Catalogue, 5 ; Work of the Year, 33
TELEGRAPH, THE : Imperfect, 82 ; for Lifeboat Stations, 2 ; Highest Office, 241 ; Prevision of, 113 ; Rates Reduced, 481 ; Saved by Wires, 420
Telegraphic Congress, International, 241, 261, 282, 339, 359, 381, 388, 481, 483
Telegraphing Drawings, 2
Telegraphing with Dynamos, 362
Telegraphing, Speed Competition, 343
Telegraphing, Rapid, 24
TELEPHONE : Long Distance in America, 419 ; Anglo-Portuguese Company's Meetings, 397 ; in Austria, Rysselberghe's System, 122 ; Austrian Company's Meetings, 280 ; Bell's Patents, 161 ; between Breslau and Berlin, 181, 261 ; between Berlin and Vienna, 101 ; Bourseul, the Inventor of, 460 ; China and Japan Company's Meetings, 377 ; at Cleveland (U.S.), Long Mileage, 201 ; a Company's Liabilities, 396 ; Co-operative Proposals in Glasgow and Manchester, 3, 181 ; Directory, The Scottish, 122 ; Egypt Company's Meeting, 259 ; in France, 121 ; in Germany, 399 ; Government and the Companies, 500 ; in Italy, 101 ; in Leicester, The Use of, 3 ; Long Private Line, 359 ; between Manchester and London, 83 ; The Megaphone, 319 ; in Mexico, 379 ; Mix and Genest's, 313 ; The Molecular, 319 ; to the Mumbles, 299 ; in North Scotland, 319 ; "Not at Home" Signal Wanted, 320 ; in Paris, 201 ; between Paris and Brussels, 281 ; in Persia, 221 ; between Pesth and Vienna, 1 ; at Port Said, 181 ; Publication of the *Journal*, 17 ; between St. Petersburg and Moscow, 121 ; in Scotland, 482 ; and Ships, 102, 122 ; in Spain, 221 ; in South Germany, 281 ; Telegrams forwarded by, 319 ; Testu's, 222 ; Transmitter, Carbon Deposit in, F. B. Hawes, 179 ; in Tunis, 101 ; Use of in Case of Fire, etc., 3 ; in the West of England 382 ; Wires, Destruction of, 302 ; Underground Wires in Germany, 182.
Telephonists, Blind, 339
Telpher Cars, The Taxing of, 24
Telpher Line at East Pool, 320 ; in Rome, 319
Tesla, N., Biography of, 163 ; his Motor, 16, 124, 419
Testing Cables, Hoskier's Book on, 2, 132
Thames, Bridging the, 361
Theatre Doors, Electric, 62
Theatre Lighting, 2, 103, 379, 419, 441, 479, 500
Theories of Electrical Traction, H. B. Carhart, 18, 38
Theory, A (Leading Article), 170
Thermo-Electricity, 500
Thermo-Magnetic Apparatus, 482
Thomson, E.: Alternating Current Phenomena, 332, 345 ; his Experiments, J. A. Fleming, 411, 431, 450, 474, 479 ; Safety Devices, 234, 252
Thompson, S. P. : Electric Splashes, 99 ; the Electromagnet, 43, 110 ; and Inverse Squares, 130, 151 ; Kœnig's Researches, 456
Thomson, Sir W., Safety of Electric Lighting, 184
THOMSON-HOUSTON : Electric Locomotive, 399 ; Motors, 165 ; Profits of American Company, 419 ; Tramcars, 62, 481
Thomson, Welding Patents, 41
Thunderstorms, S. Bidwell, 124
Time Distribution, 481
Tin, Electrolytic Production of, 419
Tomlinson, H., Villari Critical Points in Nickel and Iron, 249, 476
Tomlinson-Walker's Pulleys, 181
Tonquin and China Telegraphs, 399
"Too Soon," Local Authorities and Electric Lighting, 349
Toothache, Curing the, 499
Tornos, De, Don Lucas, Death of, 43
Torpedoes, Electric, 281
Toulouse Station, 48
Traction Increased by Electricity, 483
Trade, The, and the Public, 210
Train Indicator, 21
Train Lighting, 61, 460
Train Signal, Electric, 320
Trains, Telegraphing to, 161
Tramcar, Hughes and Lancaster's, 205
Tramways in India, 42
TRAMWAYS, ELECTRIC (*see also* RAILWAYS and ELECTRIC TRACTION) : Accident through Neglect of Rules, 241 ; Allsop's System, 390, 430 ; Alternate Motors for, 360 ; in America, 62, 401 ; The Barking-road at Whitsuntide, 419, 440 ; for Berlin, 101, 339, 399 ; in Birmingham, 323, 487 ; in Boston (U.S), 241, 399, 439 ; Brake for, 182, 443 ; in Brussels, 245 ; at Clermont-Ferrand, 23 ; A Large Contract, 212 ; *Daily News* on, 58 ; Data Concerning, A. Reckenzaun, 364 : Elieson *v.* Crompton, 439, 468, 475 ; E. P. S. Cells for, 381 ; Extension of, 83 ; from the Hague to Schevingen, 121 ; for Hanover, 21, 282 ; for Hardingstone, 339 ; C. L. Hutchinson on, 350, 390 ; Jarman's, 500 ; in Kansas City, 263 ; at La Grande (Oregon), 440 ; Lassoed by the Trolley, 340 ; Lea Bridge Company's Challenge, 50 ; at Lichterfeld, 419 ; Lineff's System, 504 ; in Liverpool, 262, 460 ; for London, 82 ; between Manchester and Middleton, 459 ; in Minneapolis, 101, 212, 262 ; Model, 479 ; More Companies, 469 ; at Munden and Potsdam, 101 ; on North Metropolitan Company's Lines, 21, 83, 104, 262, 459 ; in Paris, 61, 221, 243 ; a Rival, 205 ; at Rochester (U.S.), 399 ; at Rome, 63, 102 ; Series Traction Company's Work, 62 ; Short's System in America, 301 ; in Sioux City, 439 ; for Southend, 403, 440 ; and the South London Tramway Company, 201 ; F. J. Sprague on, 192 ; Storage Cars in America, 182 ; Storage Batteries for, Fitzgerald's Experiment, 320 ; as a Street Sprinkler, 242 ; Supplementary Storage Cars, 360 ; Thomson-Houston, 62, 481 ; in Vienna, 439 ; Waller-Manville Conduit System, 324, 369, 390, 409, 430 ; for Washington, 1 ; Westinghouse's, 499 ; Westinghouse-Pullman Combination, 460 ; Wynne's System, 176, 347, 389
TRANSFORMERS : Doubrava's, 141 ; Ganz and Co. *v.* Gaulard and Gibbs, 121 ; King's, 379 ; H. J. Ryan on, 35, 57, 76 ; Tests of, Duncan and Hasson, 314 ; Westinghouse's, N. Marshall, 85 ; and Earth, S. F. Walker, 508
Trotter, A. P., Scales for Galvanometers, 179 ; Recording Instruments, 179
Trusts, American, Opposition to, 281, 319
Turning-Lathes, by J. Lukin, 102

U.

Underground Railway (London) and Electricity, 321
UNDERGROUND WIRES (*see* WIRES)
Unit, Price of, at Eastbourne, 329, 335, 340
Unit of Self-Induction, 379
Units, 122
Units, Electrical, Conference of, 324
United Asbestos Company, Change of Address, 200 ; New Branch Office, 338
United Electrical Engineering Company, Work of the Year, 15
United River Plate Telephone Company, Meetings, etc., 20, 59
Urquhart, J. W., Electric Light, 77

V.

Verity and Sons : Artistic Fittings, 4 ; Concert, 203 ; Work of the Year, 15
Vienna Electricitäts Gesellschaft, 261
Vienna Exhibition, 439
Villari Critical Points in Iron, H. Tomlinson, 249, 476
Voltmeters : Dovilo's, 58 ; Jones and Hall's, 189

W.

WALKER, S. F. : Incandescent *v.* Arc Lamps, 6 ; Lightning and Colliery Ropes, 422 ; A Plea for the Electrical Engineer, 286 ; Transformers and Earth, 508
Waller-Manville Conduit System, 324, 369, 390, 409, 430
Warships and Electricity, 143
Watching Bills, Cost of, 419
Watchman's Signal, Single Circuit, 360
Water, Purification of, 41
Water Power, Utilisation of, 61, 101, 184, 201, 299, 301, 419
Watt, A., Cobalt Plating, 232 ; Electrolysis of Platinum Salts, 166, 186, 206
Weather Prediction, 94
Weber's Electrodynamic Law, 359
Webster's Process of Sewage Purification, 164
Weems Electric Express, 359
Wehr's Catalogue, 400
WELDING, ELECTRIC : Notes on, 26, 41, 102, 122, 201, 241, 281, 282, 300, 339, 499 ; Demonstration of, 342 ; Formation of Company, 441 ; Kennedy's Report on, 496 ; at Newcastle, 461 ; for Projectiles, 340, 439 ; Report of United States Commission, 247 ; Strength of, 300
Welding by Electricity, Sir F. Bramwell, 305
Welding and Hammering Machine, Hedsworth's, 211
Western African Telegraph Co., Meetings, 514
West Coast of America Telegraph Company, Meetings, etc., 20, 378, 397
West of England Telephone Company, 382
West India Telegraph Company, Meetings, etc., 318, 358, 377
West London Tramways, 41
Western and Brazilian Telegraph Company, Meetings, etc., 338, 378, 398
Western Counties Telephone Company : Meetings, 456 ; Work of the Year, 33
Western Electrician and Units, 122
Western Union Company : New Cables, 82 ; Meetings, 220 ; Purchase of Telegraphs by, 399 ; W. H. Astor Elected a Director, 261
WESTINGHOUSE : His American Works, 144 ; Arc System, 22, 141, 291, 339 ; Converters, by N. Marshall, 85 ; and 4,000 Volts Distribution, 42 ; and New York Subways, 161 ; and Pullman Combination, 460, 479 ; Stations, 163
Westminster Electric Supply Company, Meetings, etc., 123, 181, 259, 323, 340
Weybridge, Trees at, 482
Weymersch's Battery, 121, 161, 183, 187, 321, 510
"Whipple's Electrical Reports," 339
Whitehaven Gas Company's Bill, 499
Wilke, Herr, Continuous Current without Commutators, 16
Willans and Robinson, Work of the Year, 33
Wire-Covering Machine, Barraclough's, 208, 264
Wire-Cutting Tool, 419
WIRES (OVERHEAD) : in Boston (U.S.), 21 ; Conduits for in America, 300 ; Deaths from, 319, 339 ; in Dover, 320 ; in Dundee, 41 ; in Exeter, 81 ; in Fareham, 43 ; in Glasgow, 143, 225 ; L.C.C. Bill, 62, 141, 181, 201, 202, 299, 339, 361, 462, 479 ; in London, 62, 141, 181, 201, 202, 339, 361, 460, 462, 479, 483 ; in New York, 41, 116 ; in Rotherhithe, 299 ; Telephone, Destruction of, 302 ; Sir W. Thomson on, 184 ; Tool for Cutting, 419
Wires (Underground) : Bare *v.* Covered, 124 ; in Bavaria, 284 ; in Chicago, 439, 440 ; in Germany, 182 ; in New York, 441 ; Tatham's Conduit for, 123.
Wires, Oxidised, 202
Wiring, Concentric, 361
Wiring Houses, Interior Conduits, 185
Wiring, Insulated Staples for, 161
Wireman's Hand Cleat, 169
Wood Casings, Elliott's Almanac, 101
WOODHOUSE AND RAWSON : Award to, 479 ; Double-Pole Switch, 89, 111 ; Exhibit at Edinburgh, 425 ; at Johannesberg, 162 ; Meetings, 81, 100 ; Paper Knife, 82 ; Work of the Year, 77
Word Wanted, 282, 290, 301
Working-man's Exhibition, 282
Workmanship, Bad, 150, 157, 408
Workshops, Electricity in, 342
World's Fair, The, 241, 319
Wynne's Tram System, 176, 347, 389.

Y.

Year, Review of, 10, 30, 77, 94

Z.

Zanzibar and Mombassa, New Cable, 61
Zinc, Electrolytic Production of, 419

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NOTES.

Salonica.—The authorities of Salonica are considering the proposition of the establishment of a central electric lighting station.

Board of Trade.—Objections to the applications for provisional orders recently deposited must be sent in not later than 1st of February next.

French Dividends.—The Société l'Eclairage Electrique (capital 2,570,000f.) announces a dividend for 1889 of 18f. 6c. per share to names, and 17f. 46c. to shares to bearer.

Steam v. Electricity.—The charters asked for the new street railways for Washington contain a clause applying for powers to run the cars by "any other power than steam."

Society of Arts.—Prof. Silvanus Thompson is announced to read before the Society of Arts, at a date not yet fixed, a paper upon "The Organisation of Secondary and Technical Education in London."

Electric Mats.—One of the latest applications of electricity is the making of a floor mat that throws out heat—an electric heater, in fact, in the form of a mat. An excellent device for warming the toes.

Government Inspector.—Mr. W. Jones, of Chatham, has been appointed by the Government to supervise the electrical fittings used in the construction of vessels built for the Royal Navy at Barrow-in-Furness.

Vienna and Pesth Telephone.—The first trials were made last Saturday by the invited press of both cities of the new long-distance telephone line between Vienna and Pesth. The results are stated as perfect.

Dover.—At a special meeting, the Dover Corporation have decided, in order to prevent a monopoly being obtained by an outside company, to apply for a provisional order for supply of electricity for both public and private purposes.

Egypt.—The Council of Administration of Railways in Egypt propose to light the stations at Cairo and Alexandria with electric light from the 1st of January. For this work, a special vote of supply has been submitted to the Minister of Finances.

Royal Institution.—The Christmas juvenile lectures at the Royal Institution, by Prof. A. W. Rücker, upon electricity were commenced last Monday, and the lectures are continued to-morrow (Saturday), and on Tuesday and Thursday next week.

Portsmouth.—A memorial to the Portsmouth Town Council is being circulated, praying that the application by the Council for a provisional order be abandoned, and that the introduction of the electric light into the town by a company be encouraged.

Institution of Electrical Engineers.—The first meeting of the Institution of Electrical Engineers for the current term will take place on Thursday, the 9th inst., when the president, Dr. John Hopkinson, F.R.S., will deliver his inaugural address.

Award.—Messrs. Ruston, Proctor and Co. have received a cablegram from the Agricultural Exhibition, Santiago (Chili), advising them that they have obtained the first prize for the best portable engine in competition with the principal English and American makers.

Hammond College.—The electrical college established by Mr. Hammond, which has turned out so many good electrical engineers—high-tension men nearly all of them, now—is to be started again, according to an advertisement appearing elsewhere. We wish it the success it deserves.

Walthamstow.—The Walthamstow surveyor has been instructed to visit the public lighting at Taunton, Eastbourne, and Chelmsford (the Board being in connection with Messrs. Crompton and Co.), after which a public meeting to ascertain the wishes of the ratepayers will probably be held.

Ipswich.—The provisional order of the Brush Electrical Engineering Company for Ipswich has been discussed at the meeting of the Town Council, and the question as to their consent as local authority and the insertion of protective clauses were left for the consideration of a subcommittee.

Award.—The council of the Association of Municipal and Sanitary Engineers and Surveyors have awarded a premium of £10 to Mr. E. J. Silcock, A.M.Inst.C.E., borough engineer of King's Lynn, for his paper on "Electric Lighting," read at the annual meeting of the association held at Portsmouth.

Keswick.—A trial of the electric light was made at the Keswick Hotel on Christmas Eve, and proved highly successful. It has been lit every evening since, and at the commencement of the year the Keswick Electric Light Company expect to have the light turned on at all the places where the lamps have been fixed.

London Office.—Our contemporary the *Electrical Review* of New York has, we are informed, now taken offices at Bridge House, 181, Queen Victoria-street, London, E.C., where in future editorial communications, advertisements, or subscriptions are to be addressed to the London editor and manager, Mr. Charles Ffrench.

Electric Testing.—We have received a copy of the third edition of "Electric Testing of Telegraph Cables," by Col. V. Hoskiær. A few alterations have been made, owing to the decisions of the Congress of Electricians in 1881, and some few methods have been added to make the guide more useful as a handbook for young men who have to learn practical testing.

Electric Profits.—The electric light is becoming recognised as one of the best paying investments in America. The electric lighting company at Carbondale, Pennsylvania, as an instance of good profits, has 40 arc lights and 1,000 incandescents, the latter recently increased by another 750. From the time they started, some three years ago, the company have paid an annual dividend of 17 per cent. to the shareholders.

Tiverton.—Sir John Heathcoat-Amory is about to introduce the electric light into one of the large "dressing" rooms of Tiverton factory, where at present 150 gas jets are lit night and morning. The Thomson-Houston system of arc lighting will be adopted, and arrangements are being entered into with the Laing, Wharton, and Down Construction Syndicate, one of whose engineers, Mr. Clavil Bate, is a native of Tiverton.

The Board of Trade.—It is understood that the railway and electric lighting departments of the Board of Trade have become so large that it has been found necessary to provide other buildings for the office. The department will shortly remove to 8, Richmond-terrace, a large house that has been chiefly used for several years by Royal Commissions. The labour department of the Board of Trade will take up the vacated offices in Parliament-street.

Electricity in the Nizam's Dominions.—The Chudderghaut Municipality have received a proposal from the representative of Messrs. Siemens Bros., of London, to light the whole of the streets within the municipal limits for a yearly payment of 11,000 rupees. The firm offers to put up 13 lamps for every 20 at present in use lit with kerosene. If the terms are accepted, the Municipality would effect a saving of between 3,000 and 4,000 rupees a year, besides having the streets much better lighted.

Compressed Air.—The mains at present being laid in Paris by the Société Victor Popp are intended for distribution of power by compressed air, and not by electricity. Dynamos will be driven on the premises of consumers themselves where desired by air-engines, in the manner already carried out by the Société Popp in the Grand Boulevards, of which the Montagnes Russes is a well-known example. It is said that it is a banking house in Berlin that has found the resources for the extensions of this system.

Brussels.—The Municipality of Brussels having accorded their concessions in great part to a German company, granting only a certain portion to M. Van Rysselberghe, the well-known electrician of that city, this gentleman has written praying for a reconsideration of the decisions upon a more national basis. He suggests that his part of the work shall be allowed to proceed first, and that if it is satisfactory when finished the other concessions be also granted to him for the encouragement of Belgian industry.

Telegraphing Drawings.—The announcement has been made that M. Ginochio, an Italian, of New York, has perfected a telegraphic apparatus by which manuscript or drawings can be transmitted by telegraph drawn upon paper "wetted with chloride of calcium." We have made enquiries of the editor of the *Daily Graphic*, who we thought, of all persons, would be most likely to have heard of this or of any similar invention if there were anything practical in it, but he informs us that they have heard nothing of such a scheme.

Electric Railway in Wales.—An interesting enterprise is, so it is stated, to be undertaken in North Wales. Visitors to beauty spots in this country will remember the lovely little village of Trefriw. It is proposed to construct an electric railway—the first of its kind in Wales—to connect Trefriw with Llanrwst. If these happy hunting grounds of artists and seekers after health are to be invaded by railways, perhaps it is as well that it should be the comparatively quiet and inoffensive electric power that should enter the quiet valleys of Trefriw.

Paris Opera.—The Concert Favart, on the site of the old Opera Comique at Paris, has an installation of electric light, consisting of two semi-portable engines of 30h.p. each, with a third in reserve. These drive a compound Manchester dynamo of 200 amperes and 110 volts, and a Postel-Vinay compound dynamo of 230 amperes and 70 volts. The lighting of the entrance, the boxes, and scenes is obtained with 250 16-c.p. incandescent lamps. Besides this there are 27 Gobert arc lamps of five to 10 amperes distributed in the auditorium, scenes, and outside the building. A projector with a 25-ampere arc lamp is used for scenic effects.

Automatic Carriage Light.—The novelty of an automatic electric light box, the construction of which we illustrated a short while ago, is now introduced in the carriages of the London District Railway, even in those of the third class. A passenger places a penny in the slot, presses a button, and immediately a bright, soft light gleams upon his newspaper, but for him only, as it issues from the bottom of the box in which the apparatus is confined, and does not irradiate the pages of his neighbour's paper. He gets the whole, as nearly as possible, of his pennyworth. His coin sets in motion a clockwork meter, which gives him the light for a quarter of an hour. If his journey is longer, and he desires more light, the investment must be renewed.

Telegraphs to Lifeboat Stations.—The wreck of the "Tenby Castle" off Holyhead last week resulted in the loss of eleven lives. The persons drowned hung on desperately while a man on horseback was dispatched for the lifeboat, which only arrived in time to save one life, that of a young Malay seaman. It is more than probable had the coastguards been able to send a message by telegraph or telephone that the whole eleven lives might have been saved, for they were carried off one by one by the heavy seas as they became exhausted. Seven lives were sacrificed this spring at Ilfracombe in the same way. It is indeed a disgrace to us as the greatest maritime nation in the world, that while the lighthouses in Denmark, in Russia, Sweden, Holland, and France are fitted with telegraphs or telephones, yet Great Britain still remains without this aid to life-saving appliances.

Nottingham.—The Corporation of Nottingham having applied for a provisional order themselves, the Nottingham Electric Light and Power Company, whose steps in this direction first seriously aroused the attention of the Corporation to the importance of the ques-

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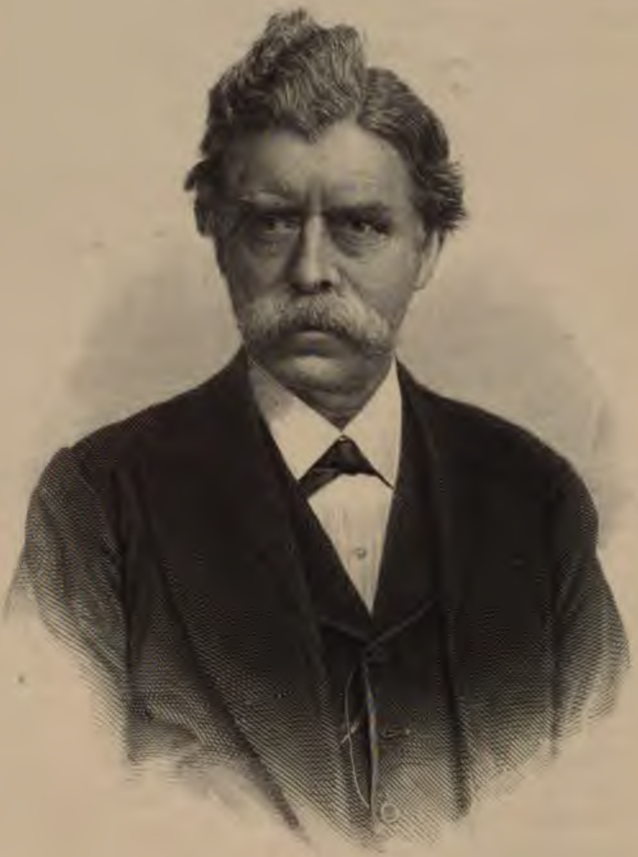

D E Hughes

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tion, are not at present proceeding with their Bill, but are offering to take over the powers when obtained by the Corporation as contractors under them. The Midland House-to-House Company, with offices in Birmingham, are also applying for a provisional order. The Corporation propose that where a consumer is charged for the actual quantity of energy supplied him, they shall be entitled to charge per quarter £5 for any quantity up to 100 units, and 1s. per unit for any quantity over that amount. The Midland Company, on the other hand, propose to charge per quarter 13s. 4d. for any quantity up to 20 units, and 8d. per unit over that quantity.

Austria.—The electric light station at the brewery in Wiener-Neustadt, already mentioned as in progress, is now completely finished, and has been working for a week or two. A Zipernowski dynamo of 50,000 watts (25 amperes and 2,000 volts), at 500 revolutions, is driven by a turbine. Only 12,000 watts are utilised for lighting, the remainder being employed for driving electric motors for the brewery. These motors are respectively of 5, 10, and 12 h.p., and are situated about 1½ miles from the dynamo. The installation of this central station is due to the influence of Herr Max von Bendt, director of the brewery of Wiener-Neustadt, and also of an incandescent lamp factory in the same neighbourhood. We believe that it was this installation which was stated to be intending to use the new Zipernowski alternate-current motors, but the account from which we copy the above details does not specficially mention the system of currents employed.

Blocking Orders.—Considerable gratification has been called out in some directions at the number of Corporations who, following Bradford, have applied for provisional orders for the erection of their own central electric light stations. These views, however, may be doomed to disappointment, for the action has in many cases been taken with a very opposite idea indeed. The attention of the Electrical Section of the Chamber of Commerce has been called to the fact that many of the notices which have been given by the local authorities of their intention to apply for provisional orders have been done with a view of blocking the extension of electric lighting owing to gas interests or other causes. The matter will be brought forward at the next meeting of the section on the 28th inst., and it is hoped that those having corroborative evidence of such action will communicate with Mr. Trotter, secretary of the section, with as many details as possible.

Candle-Power of Arc Lamps.—According to the *Centralblatt fur Electrotechnik*, the formula proposed by M. Gérard to determine the spherical luminous intensity of an arc light—namely, ½ horizontal intensity + ¼ maximum intensity—is of sufficient exactitude in practice for arc lamps fed by continuous currents. Experiments undertaken to verify this formula gave the following results expressed in candle-power:

Lamps.	I. horiz.	I. maxim.	Mean calculated.	Spherical observed.
No. 1	250	1464	491	470
2	456	3250	1040	1145
3	560	3071	1048	1221
4	744	1227	679	692
5	122	840	271	274
6	586	2100	818	802
7	935	1150	755	767

The average error is only 5 per cent., taking the whole of the lamps. The angle of the maximum intensity was about 45deg. usually, but in some cases it approached that of 30deg. or of 60deg. from the horizontal.

The Use of the Telephone.—A very important point has lately been raised by the Leicester Town Council, the Chamber of Commerce, and the Trade Protection Society concerning the restrictions placed on the use of the telephone in cases of fire or riot. The point arose in consequence of a delay in the transmission of an alarm of fire, which turned out to be a very extensive and disastrous one. The local post office officials decided that as the fire did not originate on the premises of the renter of the telephone he was not entitled to use the telephone for the purpose of informing the fire brigade, the telephone communication being restricted "to his own business and private affairs." It was also contended that even if a fire was raging next door the renter had no right to use the telephone for the purpose of giving information to the fire brigade. The public bodies appealed to the Postmaster-General on the subject as one of great importance to the commercial public. The Postmaster-General has now written to say that, while the use of the telephone is restricted to the renter's own private and business affairs, the department will be only too glad to allow its use to convey information concerning the outbreak of fires or of rioting.

Subway Railways.—A Bill, entitled "The North and South London Subway Railway," has been deposited, which, if sanctioned, will give direct communication between the north and south parts of London, whilst in the event of the Southwark Subway, already nearly completed, being extended to Clapham, communication will be given from Clapham to St. Pancras, *viâ* Newington-butts. Commencing at the northern end, the proposal is to construct a subway railway, beginning in the parish of St. Pancras, at a point on the north side of Buck-street, Camden Town, passing from thence in a direct line to Westminster, where it will cross under the Thames, and so form a junction with the City of London and Southwark Subway at their Elephant and Castle Station. Electricity will, of course, be used for driving the trains in this subway, upon the same method as that already working experimentally on the Southwark Subway. These subway lines will work in conjunction with each other, and power is now being sought by the City of London and Southwark Subway Company to enter into agreement with the London, Brighton, and South Coast and South-Eastern Railway Companies for the interchange of traffic at the London Bridge Station of these companies. The scheme for a similar subway to connect the City-road, Islington, by Moorgate-street, to the London Bridge terminus has, it is understood, been abandoned, and will not be further proceeded with next session.

Co-operative Telephones.—The proposal to form a co-operative telephone at Manchester has now resulted in practical effect. A committee was appointed, and at a meeting held in the Memorial Hall, Manchester, last week their report was submitted. The committee report that the Bell telephone expires on December 9 next, and that no existing patents stand in the way of free working after that date. Conditional undertakings have already been received for some 1,300 persons or firms at £5 per annum, and 500 private telephones have been applied for. The capital outlay would be about £12 per renter, as against £112 of the present system, though it must be remembered that the latter gives inter-town communication. The committee recommended that a company be formed with registered capital of £100,000, of which £20,000 is to be issued for the first proposed exchange in Manchester; that the head offices be in London; that the dividends be limited to 6 per cent. per annum, and the surplus profits beyond this be applied to reduce the rent of telephones. It was stated that the establishment of one telephone company for the whole country was aimed at, founded on the same ideas of co-operation with the renters, which would prevent any other company coming between the company and its customers, who, it was hoped, would also largely be shareholders. A committee was appointed to carry out the recommendations contained in the report.

Dundee.—At a meeting of the Law Committee of the Town Council last week, Mr. Hay, town clerk, submitted a report on the Electric Lighting Bill and the provisional order. In the course of the report, Mr. Hay pointed out that, as the town is well supplied with gas light, the electric light is not a necessity, and stated his opinion that there should not be a compulsory power to force the use of the light on the ratepayers, or to make them or the property of the town generally pay for the new supply, which, if successful, would only supersede the present gas light. There was a limited area given in the Bill, and it left out most of the large establishments likely to be supplied by the owners if the lighting should prove a success; but he understood that these outlying properties, in the event of failure in the system, would be subjected to their share of the loss. The deliberate opinion of the ratepayers should, he thought, be taken on the subject before proceeding with the proposals, and, if they agreed, then the system should be entrusted to a board directly representative of the ratepayers, probably the Police Commissioners, who might consider whether the best way would not be to endeavour to arrange with some of the electric lighting companies to supply the light for a time on reasonable terms, and thereby avoid the risk of laying down heavy works. After an animated discussion on the whole question, a special committee was appointed to consider the terms of the Bill and have the interests of the Council and the community attended to, on the understanding that the joint committee representing the Police Commission, Gas Commission, and Town Council should first come to a resolution in the matter.

Electric Lighting in Egypt.—It has recently been stated in various journals that the Continental Edison Company have lighted the Casino of Helouan, in Lower Egypt. A correspondent of *Revue Internationale de l'Electricité*, in giving some particulars of electric lighting in Egypt, says that Helouan is not in Lower Egypt, but in Upper Egypt, in the desert, and that the installation in question is simply the lighting of a music kiosk, Helouan not possessing a casino. The only casino existing in Lower Egypt is on the beach at Ramleh, near Alexandria, which belongs to the Olek and Ramleh Railway Company. It is lighted by 200 Edison incandescent lamps and 14 Gramme arc lamps of 15 amperes. The dynamos are modern type Gramme machines. In Lower Egypt there are some score of installations in cotton mills varying from 20 to 50 Gerard incandescent lamps of 20 to 30 c.p., as well as dynamos and arc lamps, supplied by M. Henrion, of Nancy, who uses lamps of the Pilsen type. The palace of the Khedive at Ghezieh has a temporary installation. The charitable ball given each year at the Opera House at Cairo is lighted by 1,400 Edison and Cruto lamps. The dynamos are those of Brush, the Société Lyonnaise, and Gramme. An installation has just been completed at Mansourah, at the factory of Messrs. Ralli and Sons, of 50 Gerard lamps of 50 c.p. each, supplied with Gerard dynamos. At Alexandria a central station for 500 lamps is working continuously. The station at Ramlehville is lighted from accumulators charged at the place during the day. The dynamo is driven by a petroleum-engine. It can be seen from this that electric lighting in Egypt is in a fair way of considerable extension. Nearly all the machinery is of French manufacture, and most of the work done or in course of erection has been carried out by M. Pollatschek, engineer, of Alexandria.

Artistic Fittings.—It is a pleasing feature in the progress of electric lighting that the taste of customers is leaving the comparatively cheap and inartistic fittings which at the early periods of the industry were most sought after, and is taking to a far better class of work. In the early time cheapness was the great consideration, and persons having little knowledge of what was required to make their rooms look attractive, but who at the same time would pay good prices for gas fittings, would, if they required electric fittings, haggle over the prices and seem best pleased when a flimsy rod of brass and a flexible wire with a few beads on it could be supplied for a few shillings. Now, however, that many of the best houses in town and country have, or are preparing to have the electric light, all this is changed, and the demand is running in the lines of beautiful and high class fittings at practically any price asked. We are glad that this is so, for the proper artistic fitting of that most artistic of all means of illumination, the incandescent lamp, will again redound to its credit. We called the other day at the showrooms of Messrs. B. Verity and Sons, who have made themselves *facile princeps* in the newly-developed art, and were delighted with the sight of some sets of real old Louis Seize work, upon which it is a perfect pleasure to look. It seems that Mr. Verity and Mr. Cole were both busy in this direction on their visit to Paris, and hunted all over to secure good models for their work. The result has been that they have discovered some of the most lovely pieces of this kind of work, twisted candlesticks, chandeliers, and standards, designed and chased in the delightfully old-fashioned and sincere art of that period. These they are intending to make up in electric fittings. It is needless to remark that this class of work is very expensive, the best artist-chasers having to be kept for weeks at the work of finishing, and the price for even small pieces are enough to astonish a moderate man. But it is encouraging to find that it is precisely this class of work that is now most sought for, and the pieces made are eagerly snapped up. Taste seems to be setting in the direction of highly-finished and beautiful fittings, and the art fitting manufacturer and the industry as a whole will benefit thereby.

Edinburgh Exhibition.—The French Government have formally recognised this exhibition, and it is anticipated other nations will follow this example. To accommodate foreign exhibitors, the day for closing applications for space from abroad will be February 1, the date for this country being January 15 next. The money obtained for refreshment contracts and other concessions is sufficient to pay the cost of constructing the buildings and laying out the grounds, so that the sale of season tickets and ordinary admissions will only have to be drawn upon to cover working expenses, consequently the financial prospects of the exhibition are more favourable than compared with those of the exhibition held in Edinburgh in 1886, which started with a deficit of £20,000. The following additional regulations for exhibitors have been issued for intending exhibitors: 1. The council have resolved that there shall be no rent charged for space allotted to exhibitors, unless the working of the exhibition results in a deficiency. 2. Exhibitors must deposit, along with their application for space, a sum equivalent to 2s. 6d. per square foot of space applied for. If the space allotted be less than what was applied for, the difference in the sum deposited will be returned in full. 3. If the working of the exhibition results in a loss, the amount of the loss shall be assessed primarily upon the exhibitors in proportion to the space allotted to them, and shall be deducted from their deposits. No exhibitor shall be liable for a greater amount than his proper deposit, unless in respect of any separate guarantee or obligation. 4. Upon the winding up of the affairs of the exhibition, and in the event of there being no deficiency, the full amount deposited by exhibitors shall be returned to them; but in the event of there being a deficiency, then only the balance of the deposits, after deduction of the deficiency, which will be assessed proportionally, as above mentioned. Exhibitors are held as agreeing that the amount of any deficiency, in whatsoever manner the same may arise, shall be ascertained and fixed by the certificate of the auditors of the exhibition. 5. The above concessions shall apply to past as well as to future allotments of space, and shall be held as part of the general regulations endorsed upon the official forms of application for space issued along with the prospectus. The money already paid by applicants for space will be regarded as deposit-money, subject to the foregoing rules.

Fires from Electricity.—A fire occurred at the premises of the Liverpool and London Globe Insurance Company, Dale-street, Liverpool, on December 18, which is ascribed to electricity. Fortunately, the damage was confined to the cellar, and only a few shillings' worth of damage was done, the fire brigade being quickly on the spot with a plentiful supply of water. The fire, as far as can be traced, was caused by a short piece of No. 18 wire, which had been temporarily attached to the positive main for testing purposes, coming in contact with a switch on the negative main, thus forming a short circuit and becoming overheated. The fire was limited to the destruction of about two square feet of timber casing. On Tuesday night the residence of Mr. W. A. T. Amherst, M.P., at 8, Grosvenor-square, was the scene of an alarming fire, but the firemen succeeded in getting the outbreak under control in the course of an hour. The back part of the second floor had then been completely burned out, while serious damage had been caused to other back parts of the house. The cause of the fire is stated to have been the overheating of an electric wire. That these occurrences were not more serious is due to the prompt arrival of the firemen, and it certainly behoves the electrical engineers who are responsible for the fitting to investigate whether fire office rules were properly carried out; and it equally behoves the electric light company to enquire for their own safety whether there exist any further installations with similar fittings where a fire might be started with a result which another time might be far more disastrous. We are favoured from time to time with accounts of fires from America due to faulty electric arrangements, and we are content to combat the bad effect of such accounts upon electric prospects by pointing out that electric fitting in this country is *far more* carefully carried out. This is indeed, the fact, and the greatest care is usually exercised, but a really serious fire in a case where the supply is laid on from street mains would cause a reaction in public feeling, which assurances of electrical engineers of the carefulness of their safeguards against fire would find difficult to appease. Now that public supply of electric light from street mains is looked for in all directions, the double responsibility of installer and of supply company should render the danger of fire from faulty connections at the mains practically non-existent.

Helsby Catalogue.—The Telegraph Manufacturing Company, Limited, of Helsby, and 11, Queen Victoria-street, E.C., send us an exceedingly interesting and comprehensive catalogue of "Section A, Wires and Cables." The catalogue contains some new features in a number of tables, interesting or useful to electrical engineers. At the beginning we have a table of the weight and resistance of copper wires and cables per mile, with table of French measures. After this, a ready reckoner for calculating the prices per mile, per gross, 110 or 100 yards, and per yard, which is likely to be useful to users. At the end we have tables showing the sizes of given weights of copper or cable. There is also a page of formulæ, of which a considerable feature is made, showing how to determine the size of conductors under various given conditions, the principal idea in developing the formulæ being to give the results at once in "lbs. per mile," instead of sectional area; and to present them in such a form that under any given conditions only one formula need to be used; thus—when percentage of loss is given, or the actual loss in volts is given, or when A is 1,000 amperes per square inch; or, again, when A, the amperes allowed, is given. Formulæ are also given for parallel, series and parallel series working, that is to say, when the details of lamps, etc., only is known. There is no doubt that formulæ of this nature will be exceedingly useful to those who have to lay out installations, and calculate the wires and cables, and who will be pleased to have the information presented on this compact form for easy reference. It must be said, however, that it will be well on a future edition to pay more attention to the proof-reading. If tables are given they should be absolutely accurate, and one or two errors evident always give a feeling of distrust to the rest. For instance, there are no less than seven minor errors in the table, page 2, of misplaced figures, wrong type, or commas instead of decimal points—small things in themselves of which the meaning can be gathered, but in a table quite inadmissible. The same thing occurs in the matter of quotation marks on page 31; and formula No. 15 also appears incomprehensible in its present state. It would be well to say "principal" instead of "principle idea," and "scissors" for "scizzors," as more correct. Considerable thought has evidently been given to the working out of the set of tables and formulæ in the catalogue, and we shall welcome the continuance of this feature. The catalogue itself contains lists of guttapercha and indiarubber covered wires of all kinds, flexibles, concentric and armoured cables, anti-inductive telephone cables, vulcanised rubber electric light cables, patent lead and cotton covered cables of over 1,000 megohms per mile insulation resistance for high-tension work: special flexibles for switchboards, dynamos, workshop pulleys, chandeliers, etc. The company make all the wires to standard wire gauge, and manufacture everything from the raw material themselves. The catalogue is handsomely printed, is copyright, and is priced for the public at one shilling.

PROF. D. E. HUGHES, F.R.S.

With this issue we present to our readers a steel engraved portrait of Prof. D. E. Hughes. The task is not now to write an eulogy, but we have long had the opinion that when a man inspires our admiration we should not be afraid to say so. It is a sad experience, however, that while language is so copious, it is almost impossible when specially desirable to find such words as will adequately express our thoughts. The inspiration to fashion a word picture comes not at will; if it did, we should try to picture to our readers one of Nature's gentlemen, a man of great ability, whose genius has wrested from Nature some of her secrets, which applied to human wants have revolutionised the conditions of existence. Whatever may be the merits of the controversy of prior discovery, we have always held Prof. Hughes to be the man who made telephony practical. He it was who, working with the simplest materials in a direction that to most people looked uninviting, showed how what had previously been looked upon as a great evil was in reality a greater blessing. Prof. Hughes nobly gave his investigations to the world; others reaped pecuniary rewards, but so long as humanity endures, so long will the thanks of civilised people go to the man whose portrait we have the pleasure of giving to-day. Prof. Hughes merits all the praise his *confrères* can give him. He has done good work in a double capacity. As a mechanician his devices in applying electricity have never been equalled. As an investigator his discoveries have made his name a household word. It is hardly for us here to speak of a still higher position he holds as a firm and faithful friend. The many who know and are known to him will anticipate all we could say in this direction, and agree that the sweetest words would still be harsh music to sing of one whose presence always delights and whose friendship is always sincere.

Prof. Hughes is a Londoner, born in 1831. His parents emigrated to America when he was only seven years of age, and where, before he reached his majority, he had already made his name as a musician. The world must be thankful, however, that his abilities were turned in other directions, and his proficiency in physical and mechanical science transferred him from the chair of the Professor of Music to that of Natural Philosophy. It was while professor at the College of Bardstown, Kentucky, that Prof. Hughes turned his attention to the application of electricity to telegraphy. How well he succeeded we all know; for although his instrument did not meet with much favour in England it was largely used in America, and adopted in most continental countries. Welcomed and decorated everywhere, except by the land of his birth; but he understands our phlegmatic temperament, and that though Englishmen are not usually prone to hero worship by means of titles and orders, they are sound to the heart's core, recognising the man a prince among them, honouring him individually, and appreciating the merit of his works. As we have previously mentioned, to Prof. Hughes we owe the microphone and many of its ingenious developments. Upon his researches into magnetic phenomena we will not dwell. They should be as the alphabet, well known. Prof. Hughes represented England at the 1881 Exhibition at Paris. He is a Fellow of the Royal Society, and has received the Royal Medal for his electric and magnetic researches. He is one of the Past-Presidents of the Institution of Electrical Engineers, having filled the office of president in 1886. With these few words we must leave the subject of our sketch, though, to *quote a line of Hunt's, we might* speak of him as *essentially "One who loves his fellow-men."*

LARGE INCANDESCENT ELECTRIC LAMPS versus ARC LAMPS.*

BY SYDNEY F. WALKER, M.I.E.E.

When the incandescent lamp was first introduced by Mr. Swan, two points were made against its introduction by those interested in arc lamps.

1. The energy required to furnish a given standard of light, measured by the photometer, was 10 times as great when the current was used to raise a carbon filament to a white heat as when used to vaporise carbon in the voltaic arc.

2. The quantity of light that could be obtained from an incandescent lamp was very small, so that it was exceedingly doubtful if this form of electric lamp would have any effect at all upon the use of the arc lamp, except perhaps to increase it by extending the use of electric lighting generally.

In fact, for some years subsequent to its introduction, the 16-c.p. or 20-c.p. lamp was the largest obtainable for practical work. Many attempts were made to introduce 50-c p. and 100-c.p. lamps, but they were all failures until very recently, usually taking very much more than their share of current, giving a very doubtful candle-power, and having a very short life. Electric lighting has remained in very much the same state for several years. Only the arc lamp could be used to illuminate large spaces, only the incandescent lamp small spaces; while in places such as coaling-screens, confined pit banks, and fitting-shops, there has been a continual struggle, sometimes one form and sometimes the other being triumphant. Where a large amount of light has been the desideratum, the arc has won; where absence of attention, its rival. At the Jubilee Exhibition at Newcastle, however, a lamp was exhibited, made on the incandescent plan, and of powers from 100 c.p. upwards, A great deal was said at the time about the power required for the lamp, its short life, etc.; but it was quite evident that if it could be made at a reasonable cost, and of fair duration, it would become a formidable competitor with the arc. The "Sunbeam" lamp, as it was called, beginning with a life of a few hundred hours, and low candle-power, has been gradually increasing its life and the amount of light that may be obtained from it; till, at the present time and for at least 12 months past, it is not a question of whether a given space can be illuminated entirely by means of incandescent lamps, but whether it is cheaper to use these large incandescent lamps or arcs. The object of the present paper is to discuss this question. The Sunbeam lamp is now made of any power from 150 c.p. to 1,500 c.p.; and the writer understands that a 3,000-c.p. lamp was recently made to order. The Edison-Swan lamp is made of any power, from the small microscopical lamps used for surgical purposes up to 1,000 c.p. The regular stock sizes of the latter are 8 c.p., 10 c.p., 12 c.p., 16 c.p., 25 c.p., 32 c.p., 50 c.p., 100 c.p., 200 c.p., 300 c.p., 400 c.p., 500 c.p., 600 c.p., 800 c.p., and 1,000 c p. Both types of lamp, Sunbeam and Edison-Swan, are made to any voltage required, except the very small lamps, so that it is now practicable to have any lamp of any power at any place, provided the cables be arranged for it and there be power in the dynamo and engine. A lamp of 16 c.p. and one of 1,500 c.p. may be taken from the same mains, and from the same points in them if desired.

The Sunbeam lamp is made in two qualities, the A, or high efficiency, and the B, or long duration. The A type take 2 watts per candle-power. The B type take $2\frac{1}{2}$ watts per candle-power. Thus, on a 100-volt circuit, a 500-c.p. lamp of the A type takes $\frac{500 \times 2}{100} = 10$ amperes; one of the B type takes $\frac{500 \times 2\frac{1}{2}}{100} = 12\frac{1}{2}$ amperes. The Edison-Swan lamps all take from 3 to $3\frac{1}{2}$ watts per candle-power. Thus a 500-c.p. Edison-Swan lamp takes $\frac{500 \times 3\frac{1}{2}}{100} = 17\frac{1}{2}$ amperes to 15 amperes. On a 50-volt circuit the figures for the current would, of course, be doubled—viz., 20 and 25 amperes with the Sunbeam, 30 and 35 amperes with the Edison-

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* Paper read at the recent meeting of the South Wales Institute of Engineers.

Swan. Next comes the question, What will be the relative cost of working with an arc lamp and an incandescent lamp? It may be remarked, *en passant*, that the first cost of a Sunbeam or Edison-Swan lamp, say, of 500 c.p., will be from one fourth to one-fifth the cost of an arc lamp taking the same current. The illuminating power of a large incandescent lamp would appear, at first sight, to be considerably less than that of the arc lamp for the same expenditure of energy; but in practice the disproportion is by no means so great as would be imagined. With the A type of Sunbeam lamp, taking only 2 watts per candle-power against 3½ watts of the Edison-Swan, the original proportion 10 : 1 for illuminating power of arc lamps, in proportion to that of incandescent lamps, is reduced to less than 6 : 1. In addition to that, too, it must be remembered that a considerable portion of the light given by the arc lamp is wasted. It often has to be shaded by ground glass or opal, and while its rays are visible at a considerable distance, the very deep shadows it casts on surrounding objects often render additional lamps necessary that would not otherwise be so. In practice, therefore, so far as the writer's experience has gone, the ratio for large open spaces is only as 2 : 1. That is to say, if in a large open space an arc lamp, using, say, 500 watts, is to be displaced by a Sunbeam lamp, one using 1,000 watts would be required. For confined spaces, however, the ratio is apparently 1 : 1; that is to say, the same current and the same E.M.F. used in a Sunbeam lamp will give the same light for practical purposes as the arc lamp. The light from the Sunbeam lamp would not be seen at so great a distance as that from the arc, but in the immediate neighbourhood men are able to work equally as well as regards the light given, and better on account of its being steadier. With Edison-Swan lamps, of course, the figures would be as 3 or more ; 1 for open areas, and as 1½ : 1 for confined spaces. It may be remarked also that its great convenience for subdivision renders the incandescent lamp more economical than the arc in a great many instances. In many cases, as already remarked, two or more arc lamps are rendered necessary on account of the shadows each one casts. Each lamp might have been half or quarter the power, if the arc could have been subdivided; so that sometimes even two arcs may be displaced by two Sunbeams, using together only the energy of one arc. Then, as to working cost, take as a standard an arc lamp using 500 watts (50 volts 10 amperes). Its running expenses will be for 1,000 hours :

For coal for 1,000 i.h.p. hours at 5lb. per i.h.p. hour and 10s. per ton	£1	2	6
For 11 mm. carbons at £5. 5s. per 1,000, allowing that one carbon lasts eight hours, without waste	0	13	1½
For attendance, cleaning lamps, changing carbons, allowing one man, at 30s. per week, for a circuit of 16 lamps, burning an average of 40 hours per week	2	6	10½
	£4	2	6

The running expenses of a Sunbeam lamp, taking 500 watts for 1,000 hours, would be :

For coal, as before	£1	2	6
,, one lamp, average 1,000 hours	0	13	0
	£1	15	6

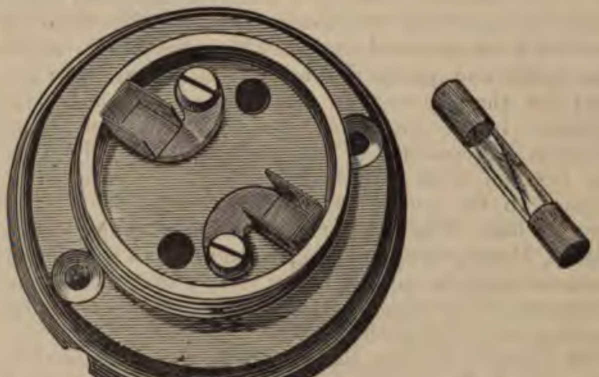
The running expenses of the 1,000-watt lamp, which would take the place of the 500-watt arc, in open spaces would be :

For coal for 2,000 i.h.p. hours	£2	5	0
,, one lamp, average 1,000 hours	1	2	0
	£3	7	0

It will be observed that no allowance is made for attendance on the Sunbeam lamps, as none is required, except when the lamp is changed. No account has been taken of waste carbons, repairs to lamps, etc. So that the cost of the Sunbeam lamp in confined spaces is less than half that of the arc, and in open spaces about 20 per cent. less, allowing for attendance, under favourable conditions. In addition to the above, the incandescent lamp has the enormous advantage of being always ready for work without cleaning, and of giving an absolutely steady light. No arc lamp can be relied upon for either, under many conditions that occur in practice. Further, the incandescent lamp has the advantage that it can be used on any circuit without special arrangement. It will work from a series-wound, shunt-wound, compound-wound, alternate-current dynamo, from a transformer or from an accumulator. It will work in series or in parallel, and can be arranged for any power on either plan. Thus, on a 10-ampere series circuit such as the "Brush," if 1,000 watts be required, two arc lamps are displaced, the Sunbeam lamp using 100 volts 10 amperes, instead of 50 volts 10 amperes. If a 1,000-c.p. lamp were required, 200 volts 10 amperes would furnish it on the series system, 100 volts 20 amperes on the parallel system. The writer has also had them running in series with arc lamps upon alternate-current and continuous-current circuits, with marked success. He therefore concludes that, if the figures and reasoning given above be correct, there can be no possible doubt that, for all industrial work at least, where the plant is in the hands of the owners of the works, the large incandescent lamp, and particularly the Sunbeam, is far and away superior to the arc all round.

SCOTT'S PATENT INSTANTANEOUS FUSES.

One of the great disadvantages of the ordinary tin, lead, or composition fuses is the time they take to act; they have comparatively such a large mass that the current they will take momentarily on a short circuit before fusing is much greater than that which will fuse them when tried through resistances. This fact has brought magnetic cut-outs into disrepute, as a short circuit in a single lamp circuit invariably, with ordinary fuses, makes the magnetic cut-out in the main circuit go, while sometimes the small fuse itself goes and sometimes not.



Scott's Instantaneous Fuse.

The new form of fuse illustrated herewith is being introduced by Messrs. Laurence, Paris, and Scott, Limited, of Norwich. The fuses are made of high conductivity wire, extremely fine, of such small mass that the current through them on a short circuit never reaches anything like double what they will go at with a gradually increasing current. Repeated experiments with the No. 1 fuse, which is intended to carry up to 1·5 amperes regularly, have shown its fusing current, when gradually increased, to be from 2·25 to 2·6 amperes, and when short-circuited without appreciable resistance, through a magnetic cut-out, the latter must be adjusted to go at less than four amperes, before it will cut out at the same time as the fuse. Another experiment repeatedly made is to short-circuit the fuse through an ammeter, measuring up to five amperes, the needle simply giving a slight kick; a larger ammeter is unaffected. Few people, with any regard for their instruments, would like to try this experiment with an ordinary fuse.

The fine wire in these fuses is silver-gilt, and is enclosed in a glass tube as shown, the ends being soldered to the caps; the caps make spring contact in three places on each cap in the fuse-boxes. All the No. 1 fuses are tested with two amperes before being sent out. They have been in practical use for some months, and have given entire satisfaction.

The fuse itself, though very fragile, is of a material that is quite unaffected by the atmosphere, and is so supported and enclosed that it is practically indestructible except by an excessive current. It is very easily placed in the fuse-box, and, what is very important from a fire insurance point of view, there is not the same facility for replacing a broken fuse by any handy bit of wire as there is with the ordinary fuse with terminal screws. There is also 1in. break, usually stipulated for in fire insurance rules.

THE CENTRAL LONDON RAILWAY.

The opposition that we prophesied to the Central London Railway by the tradesmen and others along Oxford-street and elsewhere has come, and with virulence born of fear for their trade prospects, but more from sheer ignorance of what it is proposed to do. One of the great London dailies, indeed, seems to have misunderstood its scope, and speaks of the electric railway as if it were modelled on the pattern of American street railroads, and ran along the surface of the road "among carriages, cabs, omnibuses . . . silent, perhaps, but not wholly safe." At the Oxford-street tradesman's meeting it was maintained that the proposal was an outrage on private property, that it would entail most serious loss to the shops along the route, as, notwithstanding what engineers might promise, they knew from previous experience that traffic would be impeded for at least three years and many tradesmen would be ruined. At the Ward of Cheap meeting the scheme came in for a perfect shower of opprobrium—freeholds would be injured, houses would collapse, the foundations of St. Paul's Cathedral would be endangered, and one indignant Common Councilman described the proposed railway as a "Juggernaut." All the criticism and virulent opposition is based upon an entirely wrong idea of the nature of the proposed railway, and it has been suggested by a high civic authority that a simple statement for distribution to the public would be useful, of what electrical engineers know to be one of the most useful and practical schemes which have been proposed for the convenience of the London public. The engineers have therefore prepared an authorised statement explanatory of the project, showing its absolute freedom from anything which can cause inconvenience to the public or to the owners of property along the line. The solicitors to the undertaking, Messrs. Ashurst, Morris, Crisp, and Co., in sending us a copy of this statement take the opportunity of stating that there is no foundation for the rumour recently circulated that it is not intended to proceed with the Bill.

The Central London Railway is proposed to start at Queen's-road, Bayswater, to pass under Bayswater-road, Oxford-street, Holborn, Newgate-street, Cheapside, and King William-street, and to terminate near the eastern end of King William-street by a junction with the recently constructed City and Southwark Subway. The latter electric railway, starting from a point near the Monument, passes under the Thames near London Bridge, under the large building known as Hibernia Wharf, along the Borough, past The Elephant and Castle, and along Kennington Park-road and Clapham-road to The Swan at Stockwell. The construction of this line, which has been carried out under the immediate supervision of Mr. J. H. Greathead, with Sir John Fowler and Mr. B. Baker as consulting engineers, is virtually completed. Is has been made without occasioning any interference with the surface of the streets or any stoppage of traffic. The promoters lay great stress upon these facts, which, they submit, should go far to dispel all such apprehensions as that the traffic of Oxford-street will be temporarily diverted or in some way prejudiced during the construction of the works.

There will be altogether about nine stations along the route of the Central London Railway, at an average distance from each other of about half a mile. The principal stations will be in the vicinity of Queen's-road, Bayswater, the Marble Arch, Oxford-circus, Tottenham Court-road, the Holborn Restaurant, Holborn-circus, the Post Office, and the Mansion House.

The mode of construction proposed to be adopted in the case of this railway (except as regards the stations) is practically the same as that used in the case of the City and Southwark Subway. There will be two iron tubes, or tunnels, of about 11ft. internal diameter. One will be used for the up traffic, the other for the down traffic. A steel shield with a cutting edge will be forced by powerful hydraulic pressure into the clay in advance of the excavation, so as to obviate the slightest risk of movement in the ground over or near to the tunnels. The iron tunnel as it is placed in position will be grouted with blue lias lime in a semi-liquid state, which, when it sets, becomes virtually stone, and the result is an iron tunnel cased in stone, the strength and durability of which will be enormous. The same system of construction will be adopted for the stations, which will be of iron, instead of brickwork as in the City and Southwark Subway.

In order to drive these tunnels, the sites of the proposed stations will be first acquired, and shafts will be sunk on the private property so acquired, and not in the streets. The spoil will be brought to the surface by these shafts, and the material for constructing the railway will be passed down through them. The work can be carried on simultaneously in both directions from all the station sites.

In the construction of the railway there will be no interference with the surface of the streets, and consequently no stoppage of the traffic. The engineers, from past experience, are so confident that the railway can be constructed without any such interference that the promoters have voluntarily inserted in the Bill a clause prohibiting the company from breaking up or disturbing the surface of any street or road for the purpose of constructing the railway.

The railway will be constructed in the clay at an average depth of about 50ft. below the surface, to avoid interference with sewers or with cellars or vaults belonging to property on the line of route.

The railway will be worked and lighted by electricity. The electric locomotives now being built for the City and Southwark Subway proved, on trial on that line, to be capable of moving the loaded trains at a speed of 25 miles an hour with ease, and a higher speed could be attained if desired.

There will be hydraulic lifts of large capacity at all the stations, by means of which passengers will be conveyed quickly and comfortably between the street level and the railway below. There will also be supplementary staircases at every station.

There will be no difficulty in maintaining pure air in the tunnels. There being no smoke, and the trains in each tunnel running always in one direction, perfect ventilation will be maintained. In fact, the difficulty will be not so much to get fresh air as to prevent too great a draught.

The engineers do not consider that there can be any structural injury to premises on the line of route by the construction of the railway. The stations, as well as the tunnels, will be constructed in iron, and by adopting this course it is believed that the possibility of any such comparatively slight damage as has been occasioned in the construction of some of the stations of the City and Southwark Subway will be avoided. But, of course, if any property should be injured, compensation for such injury will be paid.

The company do not in their Bill ask for powers to take part only of premises ; that is to say, they do not ask to be allowed to take the cellars or basement of a house without taking the remainder of the property affected. There is some property at the east end of King William-street under which it is proposed to carry the line forming the junction between the Central London Railway and the City and Southwark Subway. The railway at this point will be at a great depth, and the company will, therefore, ask to be allowed to acquire the right to pass under these buildings without acquiring the property, but, of course, paying compensation for the easement. This is the only case in which it is proposed, in constructing the railway, to actually pass underneath buildings.

The principal advantages of the proposed railway will be the quicker means of transit which will be obtained. At the present time, if a passenger wants to go, say, from a point in the Bayswater-road to the Post Office or the Bank he has the alternative of taking an omnibus or a cab. The journey in an omnibus takes from half an hour to an hour, according to the time of day and the omnibus selected. If a cab is taken not very much time is gained, owing to the crowded state of the traffic in this great arterial thoroughfare. The speed at which the trains will run on the proposed railway will be about 14 miles an hour, including stoppages, so that if a passenger were to get in at the Marble Arch Station to go to the Post Office or the Bank, he would be landed at his destination within a quarter of an hour.

The Central London Railway must not be confounded with the London Central (Subway) Railway. The former, as has been stated, proposes a line from Queen's-road, Bayswater, to the heart of the City. The latter proposes a line from Shepherd's Bush-green along Uxbridge-road, Bayswater-road, and Oxford-street, as far as Shaftesbury-avenue, where it stops short, and is, except as regards the route, practically a revival of a Bill which was rejected last session. The Bill of last session proposed a line from St. James's-street, via Piccadilly, Shaftesbury-avenue, and Holborn, as far as Holborn-circus, but instead of tunnelling underneath sewers and roads, without interference with traffic, as will be done in the case of the Central London Railway, it was proposed to break up the streets throughout the whole length of the line, and to build subways immediately under the surface of the streets, thereby interfering with sewers, pipes, and cellars, and causing noise and vibration.

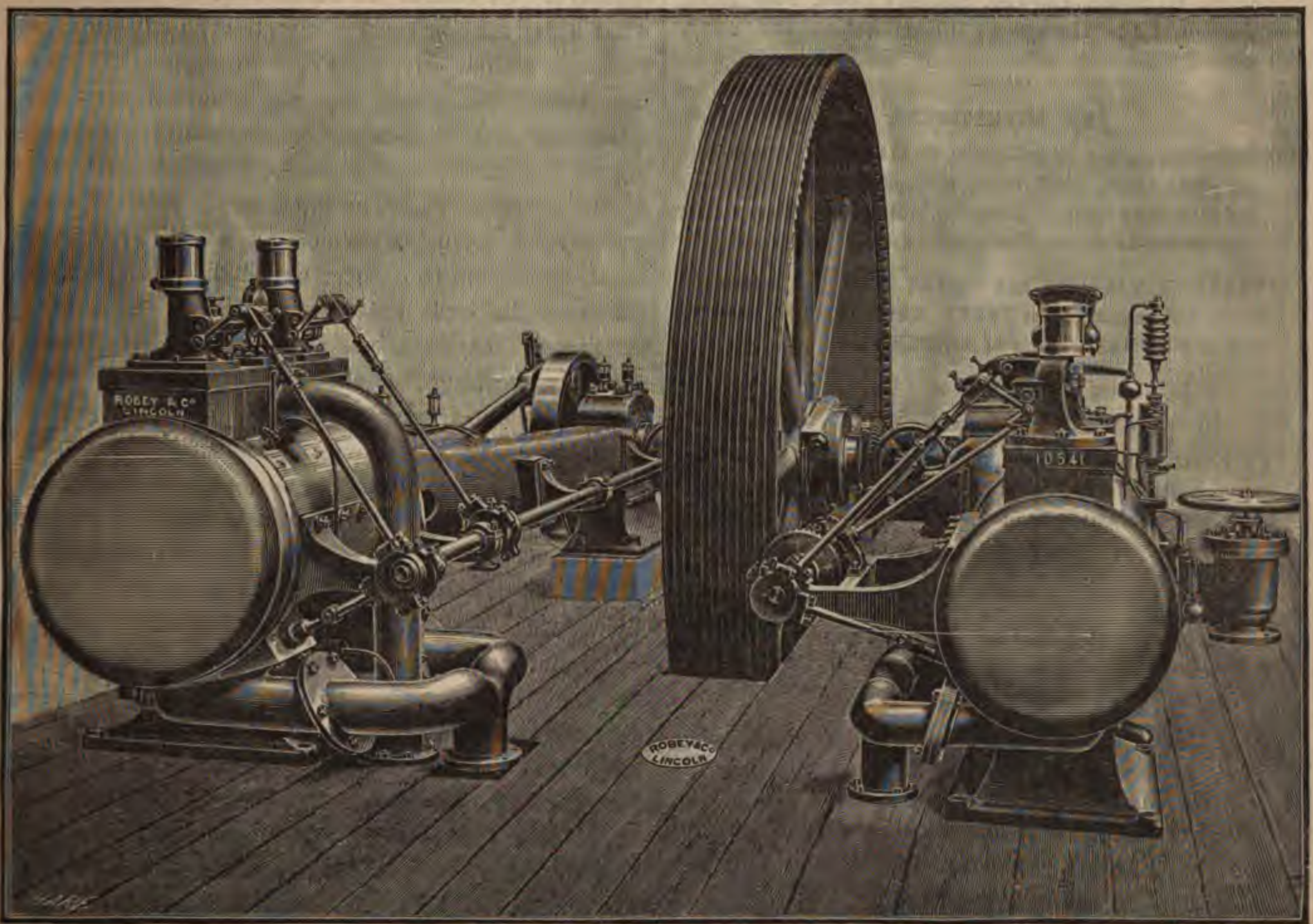
It is submitted that the Central London Railway will be of great service in that it will tend to relieve the congested state of the traffic, which, owing mainly to the enormous increase in the number of omnibuses during the last few years, is a serious and increasing difficulty, and one which is recognised by the authorities. Thus, when the London Central (Subway) Bill of last session was before a Committee of the House of Commons, the counsel for the frontagers who were opposing the Bill stated: "Undoubtedly the time must come when some better means of communication will have to be found, and therefore I cannot conceal from myself the fact that the streets of London, if population is to grow as it is now growing, will some day be inadequate to carry all the traffic which will be required to pass through them. Therefore I cannot deny, and I do not suppose any of the frontagers will deny, that any well-devised scheme which can be brought before Parliament and carried through Parliament for the purpose of meeting a want of that kind is a desideratum which we may, I will not say long for, but which we may hope some day to see accomplished."

The counsel for the Corporation and Commissioners of Sewers (who were also opposing the London Central Subway Bill) stated that his clients instructed him "To say that they would welcome heartily any well-devised scheme which would deal with the communication between the City and the other parts of London . . . . With regard to Mr. Greathead's scheme (the City of London and Southwark Subway) that was the position we took up. It is true we opposed it at the time, not on the merits of the scheme, but we thought Mr. Greathead came too near London Bridge. The whole question was very fully gone into, and ultimately we were more or less satisfied, and the opposition was dropped."

The convenience of the proposed railway in times of bad weather and fog, and when ordinary traffic is impeded by snow, is too obvious to require comment.

ROBEY'S ENGINE.

We have previously stated that Messrs. Robey have supplied the engines for the Newcastle Electric Supply Company, Limited, at Newcastle.



We herewith illustrate the type of engine so supplied. We believe that two of the engines are ultimately to be fixed, but at the time of our visit we only saw one of them, which was to drive a Mordey alternator. The builders of this engine deem that it is specially adapted for large permanent electric light installations. It is fitted with their patent trip expansion gear, and the frame of the engine is of a very substantial character, and is claimed to be a great improvement upon the original type of girder engine as first introduced into this country. The bearings are of extra large size, and are all fitted with capital lubricating arrangements for continuous running. The special feature claimed is in the arrangement of the automatic valve gear, and, so far as our examination extended, the engine seemed to be constructed in the best possible manner, and admirably adapted for the work to which it was to be put.

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With this copy of the paper is issued a portrait of PROF. D. E. HUGHES, F.R.S. *Every subscriber should receive a copy of this portrait free, and the publisher would be glad to hear from anyone who does not so receive it.*

This portrait will be followed shortly by one of Dr. Hopkinson, F.R.S., President of the Institution of Electrical Engineers.

PROSPECTIVE AND RETROSPECTIVE.

A HAPPY AND PROSPEROUS NEW YEAR.

Another year has closed its portals, and steady progress has been made during that period. There are two ways, however, in judging of progress—one purely scientific, which professes to decide as to how far gaps in our scientific knowledge have been filled ; the other concerns business, and decides whether more or better work is being done or is in prospect. It is customary to place pure science first, hence we may ask the question, what has 1889 to say for itself in this direction ? The answer is blank. Hertz and Lodge have pursued their studies into recondite questions relating more directly to the similarities between light and heat, and the latter has published an exceedingly interesting book on electricity, but neither the experiments nor the book will, at present, assist in the practical applications of the industry. Of course we admit that no one can tell what a day may bring forth, so that at any moment these or similar investigations may place information before the world that the practical man can utilise for the well-being of humanity. According to our notions of cosmology, nature and man are in antagonism. The latter in his civilised state especially is trying to extend the average length of life in opposition to nature. On the contrary, nature increases the evils that human flesh is heir to, and multiplies death-traps on every hand. Hence there is nothing so successful pecuniarily than quack medicines, which are stated by their vendors to cure every evil under the sun. Something very much of this character is as rife in the little world of electricity as in the great world of nature, and quacks abound. There are certain recognised quacks such as the hair-brush and tooth-brush man, but we refer more to scientific quacks who are to be found among the members of our so-called learned societies, who lay down the laws that regulate the scientific fashions, and relegate to the realms of heterodoxy those who venture to differ from them. Fortunately, the scientific fashions, like the fashions for bonnets and furbelows, changes, and the heterodoxy of to-day becomes the fashion of a quarter of a century hence. Thus, it must be amusing to the Lamings, and FitzGeralds, and Spragues of five-and-twenty years ago to see how their ideas have been adopted to-day with no thanks to them. They are forgotten, and the brand new discoverers or propounders flourish. Who now disputes about the "induction circuit"? yet Webb was laughed at by a good many wise people when, early in the sixties, he sent forth his little book. The man was born too early. We are gradually coming to the old faith that electricity is an entity, an entity having something akin to the properties of the ether, if it be not the ether. That electricity is indestructible, is constant in quantity, so far as this world is concerned, is another old article of faith which has been dished up anew, and seems likely to remain. The influence of Lodge as to the entity, the influence of Thompson as to the indestructibility are sufficient to command attention, even if they do not command immediate adherence.

Digression has left us in this position, that, finding nothing very new to dilate upon and to credit to 1889, we have mildly hinted that there exists a lot of electrical quackery in high quarters, and that among the more thoughtful and altogether the more powerful and able of the scientific leaders, there is a tendency to accept and rejuvenate old ideas.

Undoubtedly the most important question, from a practical point of view, is the one raised by M. F. Larroque in the early part of the year concerning the deterioration of electrical conductors. M. Larroque states that his experiments show considerable deterioration, and that in a comparatively short time. Fortunately, as yet, these results, as obtained by M. Larroque, are unique, and will require corroboration before being accepted as correct. We do not mean to infer that this gentleman has wilfully made incorrect statements, but if the results of experiments made by inexperienced observers were all published, *Punch* would have to take a back seat. That some deteriorating action takes place we are prepared to admit, and that the action is stronger for strong than for weak currents is but natural, but we cannot yet see why the action of an alternating should be worse than that of a direct current. It seems to us that the question, so far as M. Larroque has raised it, should soon be settled. There are scores of dynamos in use the armature-coils of which are subjected to the action of pretty strong currents. Have any of our makers found any signs of conductive deterioration? In one case, M. Larroque found that the resistance of a coil had increased 31 per cent. during the years in use. A good many questions upon this might be asked and would have to be answered before deciding that deterioration to this extent had taken place. Had there been any action to decrease the sectional area of the copper? Was the copper pure or what was its percentage of purity, and to what chemical actions had it been exposed during the period of use? Still, however doubtful we may be as to the accuracy of these experiments, if there is deterioration at all, some account must be taken of such deterioration in the design of every installation. Especially is this the case in electrical engineering, because the industry is principally composed of men who have imbibed, till it has become an article of faith, the necessity of mathematical accuracy in all their designs. To the engineer this mathematical proportionment of parts is a fallacy founded upon a total misconception of the requirements of the case. We are to make calculations, and pinch in copper because copper is dear, and a certain section will carry all we want. For how long if there is deterioration? And will it be cheaper to initially save copper and increase maintenance, or put in an extra handful, and, deterioration or no deterioration, the maintenance will not rise above the calculated sum for many years. In other words, to put down an installation calculated in all its parts with great accuracy, means an annually increasing cost to maintain in a state of efficiency. Put it that M. Larroque is on the right track, a five per cent. deterioration takes place per annum, resistance is increased, current is decreased, or a greater E.M.F. has to be maintained at a greater expenditure of fuel, and more frequent revolutions. This five per cent. deterioration does not mean replacement in 20 years, but in a considerably shorter period. We do know that the assumption of a five per cent. deterioration is incorrect, but the question still remains, if any, what is it?

The eyes of all English electrical engineers have during the whole year been turned to Deptford, and as time passed rumours of "going wrong" were prevalent, but an impartial investigation of these rumours and a tracing them to their foundation proved in every case that they were circulated through ignorance or spite. In a gigantic work of this kind it is impossible to foretell the exact date of being able to start, and to attempt to start before arrangements are complete would be a great mistake. So far as we are able to gather information, and the latest we have received was on the last day of the year, there is no reason, hitherto discovered or suspected, to doubt but that the Deptford installation will be a thorough success. Large numbers of men who have some knowledge of the requirements for success have inspected the works, men with rival systems, men with large experience, and none of these men come away without expressing amazement at the installation, and the seeming certainty of its success. The rumours of failure have come from men who have neither inspected the work, nor are conversant with the rudiments of what is required in electrical engineering.

A review of some of the prominent questions of to-day must contain in the forefront some reference to "dangers." Now we will take a somewhat unusual course, and charge the *Daily News* and the *Standard* with conniving at the dissemination of telegrams from America, or other paragraphs or articles from home sources, concerning the dangers of electric lighting, which are incorrect and misleading. We do not talk about the dangers of gas, and yet if men are fools enough to live in rooms with leaking gas-pipes, if they indeed permit workmen to so lay the pipes that joints are bad and leak, or pickaxes are driven through and no attempt made to stop the hole, the dangers thus arising are out of all proportion to those that arise from electricity. You do not live in a house without a roof, or without doors or windows—if you did, it would be dangerous; yet because you tolerate work of the most disgraceful character, employ men to use materials of the cheapest and flimsiest kind, drive holes into insulation, mix wires indiscriminately, you talk of the dangers of electricity. The sportsman never thinks of danger in using gunpowder, but he does not throw his flask upon the fire, an act which would be about the same as driving a spike through the insulation of high-tension currents, and hanging thereon a stove-pipe. What would we do to stop these accidents which arise simply and solely through bad—often wilfully bad—workmanship? There is no difficulty in the matter. Indict the master of the man, and the man who performed the work, for manslaughter, and whenever or wherever an accident could be unmistakably traced to such bad workmanship, or bad materials, or arrangements contrary to, say, the Phœnix Fire Office rules, to punish severely. No small fine would be satisfactory; a heavy one or imprisonment would soon do what no amount of moral suasion can do. If men will take work at a price which is known to be unremunerative, they must, to live, shirk the due performance of the work or use bad materials. We would make man and master responsible, and further make it compulsory that every master should himself, if competent, or by someone else who is competent, inspect the work before it is covered up, and give a written warranty as to its being done satisfactorily and with good materials. Technical papers can by no possible means counteract the evil which arises from the careless publication of sensational paragraphs in the daily papers. The latest accident is England is thus reported upon by Mr. Heaphy, as will be seen from the following letter, which appeared in Thursday's *Times*, from Mr. C. B. Waller, manager of the London Electric Supply Corporation :

> Sir,—Referring to the recent fire at No. 8, Grosvenor-square, and to the letter you publish to-day from Captain Edward Palliser, I beg to give you the following extract from the independent report of Mr. Musgrave Heaphy, C.E., on the subject :
>
> "I have made an examination of this installation of Mr. Amherst at 8, Grosvenor-square as far as it was possible under the circumstances. I found the work in the house was certainly not in accordance with any fire insurance rules with which I am acquainted, nor with the specification of the London Electric Supply Corporation. The conductors were in contact under the floors, they were unencased and fastened by metal staples. Among the few places that I was able to examine I found that a staple had cut into the insulation. The conductors in another place were in contact with the bell wires."
>
> I think it only right to state that Mr. Heaphy had never, until to-day, seen or had anything to do with the installation in question. At a date subsequent to the turning on of the installation No. 8, Grosvenor-square, my company, finding that so much bad work was being done in the wiring of private houses, determined to connect no further installations to their mains until, by inspection, they had been first satisfied that the work had been properly done and in accordance with their specification. Since this course has been adopted not a single instance of fire has occurred in any house in which the work has been so passed on our behalf.
>
> I need hardly add that if my company had known the facts as now placed before them by Mr. Heaphy, they would never have connected the Grosvenor-square installation to their mains, as, with work done in the way Mr. Heaphy reports, a fire, sooner or later, was, in our opinion, inevitable, whether the system of supply was a high or low tension one.
>
> I think it would have been better, in the interests of the public, if Captain Palliser [this letter appears elsewhere] had made himself acquainted with the facts before hastening to advertise his company and its supposed advantages.

We now come to the work of individual firms, and as we have watched the continuous growth of many of these firms, and are more or less intimately acquainted with the various workers therein, it is pleasant to see the record growing. It is with no intention of decreasing the value of the work or the position of other firms, when we say that as each successive year passes we are glad to see four companies retaining their position. It may at once be said that some of these firms do not view us in any favourable light, but rather the contrary incline to the opinion that we should be indicted as a nuisance and shut up. However, there they are, and those four—" The Brush," " Cromptons'," " The Edison and Swan," and " The London Electric "—have borne the brunt of the initial development of the industry. Others, like Elwell-Parker, Paris and Scott, Holmes, Blakey-Emmott, came in later, and have done good work in more recent times ; but the names of Crompton, Ferranti, Flood Page, and Garcke will ever be worthy of remembrance, as indicating men of indomitable energy and pluck, men who never faltered—or if they did, never allowed it to be seen—in the roughest times when despair had seized upon many of the most robust believers in the future of electric lighting. Year by year these men have performed herculean labours, and they have conquered. The industry is prosperous, work is abundant, and orders are plentiful. All who know him will sympathise with Mr. Ferranti, who, at the close of the year, has to experience the annoyance and troubles due to a fire at his works at the Charterhouse.

The Bernstein Company.—In the beginning of last year the business of the company had to suffer much on account of the removal of the factory to Hamburg, and consequent inability to supply goods. But after the difficulties always inherent to a new organisation had been overcome, the introduction of the series system has made more rapid progress than ever before. As the company does not undertake to do installation work, the success of the system has often been dependent on the work of others, a fact which has sometimes caused unjust reports as regards the system; but in Germany, where Mr. Bernstein undertakes to supply complete lighting plants, the series system has been very successful, and several large plants are in course of erection. Amongst the installations which are being made at present is one in Italy, in which the alternating transformer system hitherto in use is now replaced by the series system. The factory in Hamburg is amply provided with orders, and the outlook for the future is better than has ever been, a fact which is partly due to the introduction of the new improvements lately described, and partly to the better appreciation of the advantages of the series system by electricians.

Crompton and Co., Limited.—With regard to central station work, this firm have, during the past year, carried out the whole of the contract work for the Kensington and Knightsbridge Company, including the erection and part equipment of two large central stations, each of which, when complete, will eventually be on a scale sufficient to supply 130,000 10-c.p. lamps. These two stations are on the battery transformer system. The underground mains already laid on Mr. Crompton's system are eight miles in length. At Chelmsford they have just on completion a central station for lighting the town on the alternating transformer system. At Northampton they have secured the order for and are just commencing work on a central station on the battery transformer system. At Swansea they have secured the order for and are just commencing work for a central station on the same system. At Port Barry they have nearly completed a central station on the combined high-tension series arc lighting and alternating transformer system. They have secured the contract and are now commencing work on a similar station for Folkestone, and have secured a contract, particulars of which are not yet settled, for a central station for the Westminster Electric Supply Corporation.

In addition to contracts for the complete supply of central stations, they have obtained large orders for plant of the same nature for the Central Argentine Railway; for the central station at Gothenburg, through their agent, Mr. Calvert; for the Liverpool Electric Supply Company, and to the Crompton Electric Supply Company of Australia. To the last-named company they have also sent out considerable quantities of plant for private installations.

They have manufactured during the year a considerable quantity of depositing and metallurgical plant. Among these may be mentioned a very large dynamo, 2,500 amperes and 60 volts. Messrs. Crompton were the only English firm that joined the Paris syndicate for lighting the Paris Exhibition, of which lighting they took a large share, including the large and small arc lamps extending over the English, American, and Belgium sections of the Galerie des Machines, and for which they received a gold medal.

They have supplied several sets of plant to the English and Dutch Admiralty. They have fitted up eleven steamships complete, and supplied the steam dynamos for the White Star ships "Teutonic" and "Majestic." These two last are probably the lowest speed direct-driven sets ever constructed, the actual running speed being 170 revs. for 110-volt lamps.

In addition to this they have fitted up complete 93 installations, including the residences of Sir Andrew Fairbairn, Sir Horace Davey, Sir Frederick Bramwell, Lord Justice Cave, etc., the total number of lamps fitted in these installations being upwards of 11,500.

Dorman and Smith.—Being connected as manufacturers with nearly every electric light contracting firm in England, and a good many abroad, this firm is in a very good position to gauge the amount of work going on. During the whole of the year they have been kept exceedingly full of work, and although they nearly doubled their factory accommodation in the spring, a further extension is contemplated. This being the best for several years in the shipbuilding line, the demand for ships' fittings has been unprecedented, and is still maintained. Isolated plants all over the country, as shown by goods delivered direct, are greatly on the increase, while the extension of installations maintained from central stations has been more marked this year than ever. This increase has necessitated the opening of a branch office in London. Railway train lighting has increased, the firm having turned out several hundred fittings of this class, and in theatre fittings and appliances the latter part of year shows up well. Collieries are now generally adopting the light. The shipping trade has also very much improved, especially for Australia, Spain, Holland, China, and South America. Generally, it has been the heaviest year on record, and, as far as can be seen, 1890 will be better.

Drake and Gorham.—The progress of this firm has been extremely rapid during the past year, necessitating a considerable extension of their offices. The supply and shipping of generating plant for central stations, both at home and abroad, has developed into an important department, but, notwithstanding the speed of central stations, there has also been a brisk demand for complete installations, especially for country houses, and it has been repeatedly proved that the cost of lighting in the case of installations, if only medium size, is considerably below the charges made by the central station supply companies. Electricity has been successfully applied to motive power for pumping and driving electric hoists, amongst which may be mentioned the electric hoist which has been installed at the Bank of England, and is in daily use for the conveyance of both passengers and bullion. The patents of Major Cardew have been purchased, including the well-known Cardew voltmeter and the "earthing device," which obviates all danger from high-tension alternating systems. The ring contact switches still hold their own in first-class installations, and special forms are being perfected for central station work. In installation work we may mention the completion of the Bank of England by the addition of two 9 h.p. gas-engines to the existing 500-light steam plant; the Prudential Assurance installation, which now numbers 3,500 lights; Batsford Park, 300 lights; and the Inner Temple, where a 300-light steam plant has just been started. Work is either completed or in progress at Alnwick Castle for the Duke of Northumberland; Rickmansworth, for J. Saunders Gilliat, Esq.; Birtles Hall, for J. Close Brooks, Esq.; and a small central station at Oakamoor Mills, Cheadle, will supply several houses in the neighbourhood, including Farley Hall (200 lights), at a distance of a mile and a quarter. Ridgehurst has been fitted up for W. Burdon Muller, Esq.; Cringle Hall for J. Moseley, Esq., and a number of other country houses. The offices of the Provident Association and the African Bank are fitted with gas-engines and plant complete, and wiring contracts for central stations have been executed for J. Martin, Esq., Cuthbert Quilter, Esq., and many others. A department has been organised for foreign contracts, amongst which attention may be drawn to the Hotel Metropole, Sydney (800 lights), which the firm is under contract to complete by the end of this year. Also a number of installations are being carried out for other contractors, in which the firm's name does not appear.

Johnson and Phillips.—Messrs. Johnson and Phillips have been exceedingly busy in all departments of their works for many months past. The principal increase has been in electric lighting work, and they are just completing Kapp alternate-current plants for three central stations, one for the Metropolitan Company in London, another for Keswick, and a third for Hong-Kong. The growth of orders for the "Brockie-Pell" arc lamp has been remarkable, and they are coming in from all parts of the world, thus showing the high estimation in which it is held. One of the largest installations in London for these lamps is for the General Post Office, where 76 are to be placed in the sorting-rooms; another is for the lighting of the streets of Hong-Kong, whilst several more large lots are being supplied to the trade in various parts of the world.

The patent liquid insulator has been in great demand during the year for overhead electric light wires, and large numbers have been shipped to all parts. It is remarkable how quickly electric light engineers have availed themselves of this valuable insulator, whereas telephone companies, to whom it would be equally valuable, have only adopted it in one or two instances where unusual difficulties existed. The "cross talk" so much complained of in London would almost entirely disappear if these insulators were generally employed. The outlook for 1890 is extremely encouraging, and the works will start the year in full swing in every department.

Laurence, Paris, and Scott.—This company's manufacturing business shows promising signs of increasing, and during the past year, though, on the whole, very quiet, some few excellent orders have been filled, which will probably lead to others. The company exhibited at the Birmingham Electrical Exhibition, and already feel the benefit of having done so. Numerous enquiries emanated from their stand, and many orders have resulted therefrom. They also were fortunate enough to secure first-class gold medal for their dynamos and motors, being the only award specially given for dynamos and motors alone. During the past year the business has developed several patents, the principal ones being an instantaneous fuse, an improved system of laying underground mains, and they have now succeeded in perfecting a meter which, it is claimed, will register accurately both small and large currents, and will meet the much-felt want of a cheap and reliable instrument. This has been worked at for the last twelve months, and has passed through many stages to the present one, which is the outcome of long and tedious experiments and many forms of working parts. The outlook for the coming year, with these new patents to work upon, and the increased demand for dynamos and motors, is very promising, and it is expected that a considerable increase in the turn out of manufactures will result. At present the factory is fully occupied.

Paterson and Cooper.—The volume of this firm's business has greatly increased. Not only have more machines been sent out, but the average size is considerably larger than in previous years. The instrument department has been exceedingly busy during the whole of the year. For ship lighting they have supplied a greater number of machines than in former years, both rope-driven and direct running. Amongst the steamers fitted completely are the "Curfew," "Pladda," "Ardle," "Dean," "Modjeska," "St. Magnus," "Red Sea," "Rajah Brooke," "City of Venice," and yacht "Tighnamara." The end of the year finds the firm with several ships on hand. Amongst the important installations carried out in 1889 are those of the Albert Institute, Dundee; the Pontardawe Tin Plate Works, South Wales; the Overton Paper Mills, Greenock; Messrs. J. and B. Stevenson's bakeries at Battersea; Kingswood Warren, Epsom, the residence of H. C. Bonsor, Esq., M.P.; the factories of Messrs. Davis, Moore, and Co., Leicester; and the wharfs of the Dundee, Perth, and London Shipping Company at Wapping. They have also executed a large number of minor contracts, carried out wiring and extension work, and have several contracts still to finish. A greater number of orders of all kinds are on the books than at the commencement of previous years, and hopes are good of seeing a still greater extension of the business in 1890.

Phosphor Bronze Company.—The demand for patent silicium bronze electrical wire has been so great during the past year that the company has been compelled to double the plant at their rolling-mills in Birmingham. This wire is now generally acknowledged as the only reliable telephone wire for overhead use, and it is being adopted by all the leading telephone companies throughout the civilised world. The influx of orders has become greater each month, as the wire is being substituted by all old-established companies for the unsightly heavy and dangerous overhead iron, steel, and copper wires originally used; whilst the new companies, benefitting by the experience of others, are installing their systems upon the most approved principles. The phenomenal success which has attended the introduction of this important invention (patented by the company in the United Kingdom, India, and all British colonies and dependencies) is said to have produced imitators, who profess to supply or make bronze wire having similar characteristics to this patent wire. Those who require this wire should be careful to specify patent silicium bronze wire of this company's manufacture. The company has been, and still is, extremely busy in phosphor bronze ingots, castings, rods, and sheets for electrical purposes, and also in white anti-friction metals, and the prospects for 1890 are very cheering.

Ransomes, Sims, and Jefferies.—This firm, like many other firms, have been for some time past, and are still, extremely full of work, and well supplied with orders for their well-known engines for electric light work and other purposes.

Ernest Scott and Co.—The manufacture of dynamos and other electrical work was not commenced until the beginning of 1889, and, owing to pressure of business in other departments, the firm were not really able to go fully into the electrical work until about the middle of the year. From this time up to the present they have been extremely busy upon dynamos of all sizes, and also arc lamps and other electrical machinery. The standard dynamos are made in fifteen sizes, from 1,000 to 60,000 watts, but larger machines are made to order. It has been found that for machines up to five units it is advisable to use the two pole type, and they therefore make all dynamos up to this size in this manner, the advantage of the multiple type applying to the larger machines specially. Since August they have taken in hand the lighting of 16 mills in Lancashire and Yorkshire, and have shipped to foreign orders over 20 complete plants for arc and incandescent lighting. In addition to this work, a large number of dynamos have been supplied to the trade for installation work. There is in hand series arc lighting dynamos and alternating machines and transformers of various sizes. The prospects of the coming year are considered extremely bright, as enquiries for all classes of electrical machinery appear to be getting greater, and it is not customary, as it was some time since, to receive no end of enquiries and very little results—most enquiries now resulting in an order for somebody.

United Electrical Engineering Corporation.—The operations of this company are principally in connection with the heavier branches of electrical engineering, such as "electrical traction," the telpher system of cheap transport, "supply station," and "transmission," although their works on the Albert-embankment are devoted to switch safety junction regulating, etc., gear, and a wide range of general accessories. The new offices of the company are centrally situated at 3, Prince's-mansions, Victoria-street, Westminster, where a large suite of rooms are occupied, increase of business having required additional drawing and other accommodation.

A rigid rail telpher line having the exceptionally heavy grade of uniformly 1 in 11·5 has been sent from the Wood Green Station of the Great Northern Railway up the hill to the Alexander Palace, until the reopening of which, however, a press inspection is not contemplated. We understand that it demonstrates, however, the suitability of telpherage for passenger and heavy goods traffic under more onerous conditions than had previously been very generally supposed. A line of a little over a mile and a quarter in length, for the transport of 1,000 tons of tin ore per week, is now in course of construction at the well-known Eastpool tin mine in Cornwall. An order is also in hand for an equipment for a telpher line in Rome. Telpherage is thus making active progress, and we understand that contracts are in the course of active negotiation for lines in South Africa, which presents an exceptionally favourable field, and in other parts of the world.

The company is devoting particular attention to the subject of electrical traction, and exhaustive particulars of its specialities in this branch will shortly be published in pamphlet form, before which we will be enabled to describe developments now taking place. The switch gear, etc., for the Northfleet line, which we have described, was made at the company's works, which have now in hand a considerable amount of material for a tram line on the series system in Italy. During the year the Jablochkoff patent, the claims of which have been already commented upon by us, has been widely recognised, and the principal firms who desire to use the patent have agreed to pay royalties.

The works have been engaged for the prominent supply companies upon high-tension supplies, the essential feature of which is the impossibility of the conducting parts being touched by the person except by deliberate intent. The prospects for the coming year are particularly favourable, and arrangements are in progress by which the company will be interested in a largely-increased amount of supply station work of a heavy character in respect to plant requirements. The branches to which reference have been made indicate the direction in which the expansion of business has been most marked, principally from the fact that the company have recognised their importance, and have *given particular* attention to the printing of pamphlets giving particulars as to those points upon which information is most generally required. The company has been materially assisted by the co-operation of Messrs. J. G. Statter and Co., Limited, of West Drayton, from whom the heavier part of their plant requirements are obtained.

B. Verity and Sons.—The following is a brief *resume* of the principal works carried out by Messrs. Verity and Sons, Covent Garden. Some of this firm's most important installations of 1889 are those at the Duke of Fife's new mansion in Portman-square, worked by a 14 h.p. gas-engine; the Savoy Hotel, the largest private plant in the world, which was described a few weeks back in these pages; Sir John Pender's, at Foots Cray; H. Osborne O'Hagan, Esq., (two installations); the Earl of Dysart, Ham House; Sir John Dickson Poynder, Hartham Park, Wilts; the Grand Hotel, Brighton; Exeter Hall, Strand; the City Liberal Club; the British Chess Club; the Green Room Club; the Bank of Scotland; Messrs. Coutts' Bank; the New Theatre Royal, and several hotels and private houses at Exeter; several houses at Bath, and half-a-dozen Atlantic steamers. Some idea of the amount of work carried out by Messrs. B. Verity and Sons may be gathered from the fact that during the last eleven months they have used on their own works over 24,000 incandescent lamps in some 110 separate installations, an average of over two installations per week. With regard to future business, this firm has several heavy contracts in hand, and are now engaged in erecting the machinery for the electric light at Mr. D'Oyly Carte's new theatre in Charing Cross-road, where the total capacity of the plant will be nearly 3,000 lights; they are also carrying out here some interesting ventilation by fans and electric motors. In addition to several large installations in the country, they are now erecting the machinery for an important installation at Buenos Ayres, and are carrying the entire work through, including the wiring both for electric lighting and electric bells and the fittings, the latter being of the most elaborate character. Altogether, the prospects for the ensuing year seem to point to a much busier time than the past has proved. The use of electricity as a motive power is a branch to which Messrs. Verity are paying great attention, especially in the matter of ventilation, and they have brought out an improved air propeller which appears to possess many advantages over those in general use. Messrs. Verity have supplied to the trade over three times as many fittings during the past year as they did during the preceding one. They have done business with every electrical firm of standing, and the list of firms now standing in their ledgers is the best proof of the enormous work which is being done throughout this country and abroad. Large alterations have been made in their showrooms, and they now have on exhibition nearly three thousand different samples of fittings (brackets, electroliers, etc.), all of which have been designed within the last 18 months. The best designs of everyone of the French firms have been bought, most of which attracted attention in the Metal Department at the Paris Exhibition, and are now on view in their showrooms, 17 firms having been dealt with. It will be the firm's endeavour during the next three months to bring out as many electrical fittings as possible wherein the beautiful work of some of these old models will be incorporated.

Commercial Cable Company.—The numbers are published of the debentures of the Commercial Cable Company which have been drawn for payment at par on the 15th inst., from which date interest will cease.

TESLA METHOD OF OPERATING ELECTRO-MAGNETIC MOTORS.

The *Western Electrician* describes a new design of Mr. Tesla for operating motors, the main features of which are as follows:

"If an alternating current be passed through the field-coils only of a motor having two energising circuits of different self-induction and the armature-coils be short-circuited, the motor will have a strong torque, but little or no tendency to synchronism with the generator; but if the same current which energises the field be passed also through the armature-coils the tendency to remain in synchronism is very considerably increased. This is due to the fact that the maximum magnetic effects produced in the field and armature more nearly coincide. In other words, a motor is constructed having independent field-circuits of different self-induction. These are joined in derivation to a source of alternating currents. The armature is wound with one or more coils, which are connected with the field-coils through contact rings and brushes, and around the armature-coils is arranged a shunt with means for opening or closing the same. In starting this motor the shunt is closed around the armature-coils. When the current is directed through the motor, it divides between the two circuits, which, by reason of their different self-induction, secure a difference of phase between the two currents in the two branches, that produces a shifting or rotation of the poles. By the alternations of current, other currents are induced in the closed, or short-circuited, armature-coils, and the motor has a strong torque. When the desired speed is reached the shunt around the armature-coils is opened, and the current directed through both armature and field coils. Under these conditions the motor has a strong tendency to synchronism.

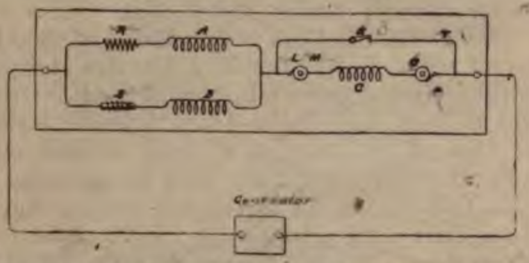


FIG. 1.—Teslá Method of Operating Electromagnetic Motors.

"In the accompanying cuts the motor is represented diagrammatically. In Fig. 1, A and B designate the field-coils of the motor. As the circuits including these coils are of different self-induction, they are represented by a resistance coil, R, in circuit with A, and a self-induction coil, S, in circuit with B. The same result may of course be secured by the winding of the coils. C is the armature circuit, the terminals of which are rings, M and O. Brushes, L and P, bear on these rings, and connect with the line and field-circuits. T is the shunt or short circuit around the armature. E is the switch in this shunt. The operation of these devices is as above described.

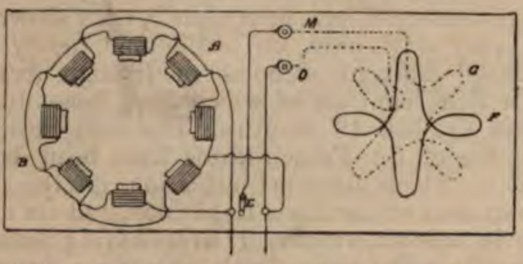


FIG. 2.—Tesla Method of Operating Electromagnetic Motors.

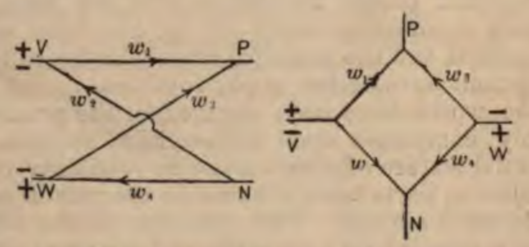
"It will be observed that in such a disposition as is illustrated in Fig. 1, the field-circuits A and B being of different self-induction, there will always be a greater lag of the current in one than the other, and that generally the armature phases will not correspond with either, but with the *resultant of both. It is therefore important to observe the proper rule in winding the armature.* For instance, if the motor have eight poles—four in each circuit—there will be four resultant poles, and hence the armature winding should be such as to produce four poles, in order to constitute a true synchronising motor.

"It is of advantage in the operation of motors of this kind to construct or wind the armature in such manner that when short-circuited on the start it will have a tendency to reach a higher speed than that which synchronises with the generator. For example, a given motor having, say, eight poles, should run, with the armature coil short circuited, at 2,000 revolutions per minute to bring it up to synchronism. It will generally happen, however, that this speed is not reached, owing to the fact that the armature and field currents do not properly correspond, so that when the current is passed through the armature (the motor not being quite up to synchronism) there is a liability that it would not "hold on," as it is termed. It is therefore preferred to so wind the motor that on the start when the armature coils are short-circuited the motor will tend to reach a speed higher than the synchronous—as, for instance, double the latter. In such case the difficulty above alluded to is not felt, for the motor will always hold up to synchronism if the synchronous speed is reached or passed. This may be accomplished in various ways, but for all practical purposes the following will suffice: The armature is wound with two sets of coils. On the start one only is short-circuited, thus producing a number of poles on the armature, which will tend to run the speed up above the synchronous limit. When such limit is reached or passed, the current is directed through the other coil, which, by increasing the number of armature poles, tends to maintain synchronism. In Fig. 2 such a disposition is shown. The motor having, say, eight poles, contains two field-circuits, A and B, of different self-induction. The armature has two coils, F and G. The coil F is closed upon itself, while the coil G is connected with the field and line through contact rings, M and O, and a switch, E. On the start the coil F alone is active, and the motor tends to run at a speed above the synchronous, but when the coil G is connected to the circuit the number of armature poles is increased, while the motor is made a true synchronous motor."

CONTINUOUS CURRENTS WITHOUT COMMUTATORS.

The *Electrical World* in its last issue thus refers to a paper by Herr Wilke:

If four resistances be connected in the manner shown in the engravings Figs. 1 and 2, the alternating current will be converted into the continuous. If w_1, w_2, w_3, w_4, are the asymmetrical resistances, which offer a very small resistance to the current when in the direction of the arrow shown, but on the other hand a very large resistance when in the opposite direction, then the current coming from the positive pole, whether entering at V or W, will be conducted to P, so that there is always a positive pole at that point; and in a similar manner a negative pole is constituted at N. It is true that a part of the current is lost in the shunt, but as the asymmetrical resistances have a large resistance for the direction of the current in the shunt, the loss is comparatively small.



FIGS. 1 and 2.—Continuous Currents without Commutators.

As the author remarked at that time, this method of connection is evidently useless as long as we do not know of any asymmetrical resistances, even though we may assume that the future may furnish such. But, he continues, we can replace the resistances by counter E.M.F.'s, and of these we possess a number of an asymmetrical character. The author also showed at that time an arrangement analogous to that described by Mr. Tesla, and illustrated in Fig. 3.

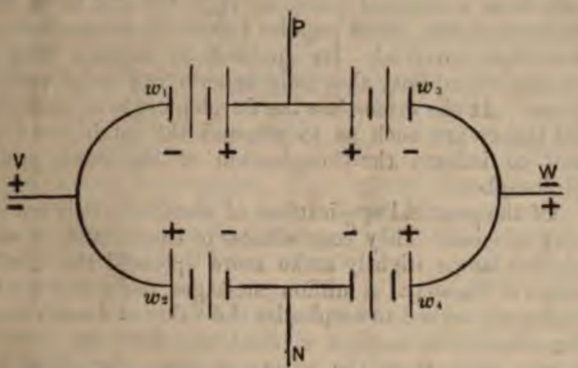


FIG. 3.—Continuous Currents without Commutators.

Coming down to the electromagnetic methods, the author claims that he had some time ago conceived the idea, and had communicated it to Herr Zipernowski on August 26 of this year. This method is illustrated in the engraving, Fig. 4. Let us suppose there are eight coils, 1, 2, 3, 4, and I., II., III., IV., wound on a ring-shaped iron core. The four coils, I., II., III., IV., are so wound, and connected among themselves, and with the source of constant current, that they convert the iron ring into a magnet without poles. The direction of the lines of force generated is supposed to be in that of the large arrows shown. Furthermore, there are the four coils, 1, 2, 3, 4, placed between the four previous ones, and so connected with each other that they generate lines of force in the direction of the small arrows shown. If the points V and W are connected respectively with a positive and a negative pole, we see that in such a case the magnetism of the parts of the ring situated under 1 and 3 is increased, but is decreased in the other two quarters, 2 and 4; but if the action of the continuous current magnetising spools I. to IV. is strong enough to saturate the iron of the ring, then only the demagnetising effects come into action, and these effect a corresponding counter-E.M.F. in the coils 2 and 4. It follows, therefore, that the coefficient of self-induction of the coils 1 to 4 is an asymmetrical one, and in consequence of this arrangement of commutating connections, as described above, the alternate currents are changed into continuous. For the excitation of the demagnetising coils, I., II., III., IV., alternate currents commutated into direct current can be employed.

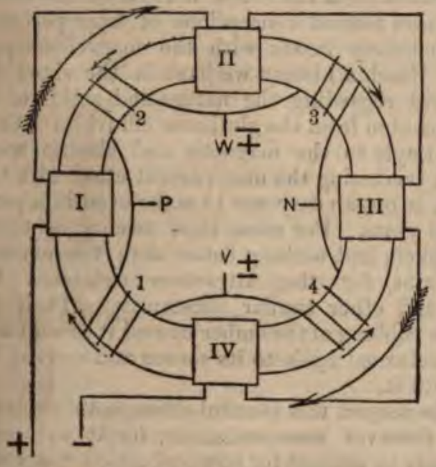


FIG. 4.—Continuous Currents without Commutators.

"The Telephone."—Messrs. William Clowes and Sons inform us that the *Telephone* ceased to be published at their office at the close of the year.

DANGERS OF ELECTRICITY.

The following among other letters have been appearing in the *Times:*

From RADCLIFFE WARD: Sir,—A well-known member of the House of Commons, speaking the other day about the explosion in the streets of New York of a subway containing electric mains—the explosion having occurred, it is supposed, through an accumulation of gas leaking into the imperfectly-constructed subway being fired by a spark from a leaky electric conductor—raised the question as to how far such an incident might affect what is probably one of the most interesting schemes to the London public for which Parliamentary powers are to be sought during the coming session. I refer to the proposed London Central Subway Railway, from the Monument, through Cheapside, Holborn, Oxford-street, Bayswater-road, out west, and which, of course, is to be worked by electricity. In view of the fact that this railway is not the only one of the kind on the *tapis*, and that there seems every probability of many such being proposed and carried out, their safety from the dangers of electricity is an interesting public question.

Fortunately there are specific reasons why such dangers cannot exist in the case of these subway railways: (1) The tunnels will be at such a depth that no gas will leak into them. They will be far below the level of the gas mains; (2) the ventilation of the tunnels will be excellent, as the rapidly succeeding trains, always in one direction, will constantly keep the air moving and draw in a fresh supply; (3) even if the tunnels were above the gas mains, it is easy to construct them gas-proof.

The large number of deaths from the high-pressure alternate-current wires which have occurred in America have very naturally excited public alarm. We, in England, however, have not much reason to feel alarmed, as high-pressure mains will not be dangerously mixed up with telephone and telegraph wires; and, further, there is no doubt that the great bulk of the electric energy supplied to the public will be in the shape of continuous current.

A vastly important source of revenue to electric supply stations is motive power; even for stationary motor purposes this is a branch almost entirely neglected hitherto in this country. However, the great demand which will be very soon felt for electric energy to charge accumulators on omnibuses, cabs, goods delivery carts of all kinds as an economical substitute for horses will cause still greater attention to be given to that form of electricity which, when properly laid on, is absolutely safe—*i.e.*, moderate pressure and continuous currents.

From Colonel PALLISER: Sir,—I see there has been an accident in Grosvenor-square, said to be due to the heating of an electric wire. If so, it must have been a wire connected with a high-tension system. The St. James's and Pall-mall Electric Lighting Company, which I started, and arranged the conditions of its introduction with the parish authorities, uses the low-tension system, from which no danger is to be apprehended. Perhaps you will be good enough to insert this letter, for the demand for the light in this, the richest part of St. James's parish, is very great. [See answer of Mr. Waller to this, given in our annual *resumé.*]

The *Daily News* has also given the following correspondence:

From BERNARD DRAKE: Sir,—Now that electric lighting supply mains are being laid down on such a large scale in London, it has become a matter of general interest to consider whether or not there is a risk to life in availing our selves of this luxurious illuminant. We are constantly being scared by reports from America, giving minute and revolting accounts of death caused by contact with the electric conductors, which, no doubt, have their origin in facts, though they do not lose in the telling. Most of these apply to the workmen engaged in manipulating the outside wires, but one case at any rate would seem unmistakably to refer to the wires within the consumer's precincts, and the correspondent draws attention to the fact that the converter cannot therefore be relied upon to perform its function of reducing the electric pressure to a harmless potential. What we require to know therefore is: 1. Under what conditions does the danger exist? 2. How can it be avoided? There are different systems in vogue for the distribution of electricity, and although the object of all is to deliver the current to the consumer at practically the same working potential, the means of obtaining this result are widely different. This variation is due to the fact that, whereas gaspipes act the part of a reservoir and help to store the gas, the electric mains entail a direct loss in transmission, the amount of which depends, first, on the distance, and, secondly, on the pressure at which a given amount of energy is conveyed. If the pressure is doubled the conductors can be halved, and the loss is the same. This has naturally tended to promote the development of high-pressure systems, which require a less initial outlay in conductors, and are able to work over a wider range. Where the supply station is located near the houses to be lit, the current is produced at once at the working pressure, and in such cases there is absolutely no danger to life or limb, but when the distance is great the case is different, and a current of great pressure is brought up to the house, and is there utilised to produce a new and independent supply of low tension by means of apparatus known as a "converter" or "transformer." This is performed by wrapping the two independent wires round a mass of laminated iron, and the result is a perfectly safe supply so long as the two wires are apart. Wires, however, though they can certainly be made to produce astounding results, are but "human" after all, and cases may occur when they wander into forbidden paths, and then comes the danger, unless provided for and overcome.

Here again ingenuity has stepped in and provided a piece of mechanism known as an "earthing device," the invention of Major Cardew, which infallibly cuts off the current if a condition of danger occurs. This apparatus is at present fixed in some instances only, as the companies are of opinion that the number of deaths is but small, and the contingency is not worth providing against, but it is to be hoped that before we have any serious accident in England the authorities will step in and make some such safeguard compulsory. The wires in America are run in such a rough-and-ready manner overhead that they must always be a source of danger to the attendants, but in London this danger is minimised by fixing the wires underground, and, provided we see that our houses are well wired, and the above-mentioned precautions are taken when a high-pressure system is used, we may consider ourselves perfectly safe, and switch on our lamps with an easy conscience.

From KILLINGWORTH HEDGES: Sir,—Your correspondent "Electron" has given a fair account of the systems now at work, but he has a leaning towards the first method—namely, the storage—and consequently has fallen into popular errors with regard to the method of distribution which is being practically worked from Deptford. The pressure is not 10,000 volts, as stated, but 6,000, and the machinery is in duplicate, each section being worked normally at half-power, but capable of doing the whole lighting in the case of a breakdown. Motors can be used with alternating currents, and there are several types in the market. To the general public the adoption of the electric light is principally a question of comparative cost with other illuminants. The placing of a generating station at Deptford, where coals are imported direct from the steamers and water costs nothing, must offer great advantages over the low-tension system, which necessitates a station close to the area of supply. There are several methods of making the secondary circuit alone, which enters the houses quite safe; the simplest plan is to connect one pole to earth, either directly or in a similar manner to that used for protecting both telegraph instruments and operators against dangers from lightning. To do this I have designed what may be called an electrical safety-valve, which in principle is similar to a Swan lamp with a broken filament. The ordinary current cannot *jump over the gap,* but directly there is an unauthorised *voltage on the current the spark leaps* across, and the *excess pressure is led harmlessly to earth.*

REVIEW OF THEORIES OF ELECTRICAL ACTION.[*]

BY PROF. HENRY S. CARHART.

The physics section of this association congratulates itself because it deals with topics of the most lively interest, not only from a practical point of view, but still more from a theoretical one. Even popular interest in electricity is now well-nigh universal. Its applications increase with such prodigious rapidity that only experts can keep pace with them. At the same time the developments in pure electrical theory are such as to astound the intelligent layman and to inflame the imagination of the most profound philosopher.

Of the practical applications of electricity it is not necessary to speak. They bear witness of themselves. A million electric lamps nightly make more splendid the illustrous name of Faraday; a million messages daily over land and under sea served to emphasise the value of Joseph Henry's contribution to modern civilisation. Blot out these two names alone from the galaxy of stars that shine in the physical firmament, take from the world the benefits of their investigations, and the civilisation of the present would become impossible. The value of the purely scientific work of such men is attested by the resulting well-being, comfort, and happiness of mankind.

But the mind can never rest satisfied with the facts and applications of a science however interesting and useful they may be. It feels an inward impulse to link the facts into a related whole, to enquire into their causes, to frame a satisfactory theory of their correlation, and so to build on them a true science. It is, indeed, interesting to study the history of any scientific doctrine and to trace its development from the crude notions of its earliest stages to the more refined conceptions of later periods, comporting indefinitely better with the marvellous processes of nature. Such a history we have in the views which have been held regarding the nature and action of electricity. The transition from the glutinous effluvium of the sagacious Robert Boyle to the magnetic and electric waves of the present, traversing the omnipresent ether with the velocity of light, is not an easy one to make even in a period of two hundred years. For more than twenty centuries natural philosophers had nothing better than the emission theory to account for the attraction exhibited by rubbed amber and other similar substances. Their notion was that the rubbing of the amber caused it to emit an effluvium which returned again to its source and carried light bodies back with it.

In one respect this fanciful attempt to explain electrical action deserves commendation; for it evinces a mental inaptitude to account for physical action "at a distance," or without some intermediate agency. Later philosophers, satisfied perhaps too easily with mathematical explanations founded on the observed laws of attraction and repulsion and not demanding a medium, did not feel the same intellectual necessity of filling the space between bodies acting on one another either with emanations from those bodies, or with an invisible, imponderable medium, suspected by no sense of man, but required only to meet a demand of his highest intelligence. For when the Newtonian philosophy had made some progress the doctrine of unctuous effluvia was given up, and physicists acquiesced in the unexplained principle of attraction and repulsion as properties of bodies communicated to them by the Divine Being, the mechanism of which they scarcely attempted to explain (Priestley). "Many superficial philosophers thought they had given a very good account of electricity, cohesion, and magnetism by calling them particular species of attraction peculiar to certain bodies."[†]

The discovery of Stephen Gray that the "electric virtue" could be conveyed along a wire for several hundred feet without sensible diminution, and the invention of the Leyden jar by Kleist or Cuneus, had the effect of annihilating many mushroom theories constructed of the slimmest basis of facts. The latter discovery disclosed a power in electricity not previously suspected, and excited the greatest interest both in Europe and America. At this period

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[*] The address delivered to Section B of the American Association for the Advancement of Science.

[†] Priestley's "History of Electricity," vol. ii, p. 18.

Franklin turned his attention to the subject, and "spent more time in diversifying facts and less in refining upon theory" than some of his European contemporaries. In fact, he tells us that he was never before engaged in any study that so totally engrossed his attention and his time.

His discovery that the two electricities are always excited in equal quantities, that the charge resides on the glass and not on the coatings of the Leyden jar, and his experimental identification of lightning with frictional electricity excited the liveliest interest abroad, and secured for him the Copley medal of the Royal Society; while his theory of positive and negative electricity made a permanent addition to the nomenclature of the science. His conceit that a turkey killed with the discharge of a battery of jars was uncommonly tender eating, a discovery gravely communicated to the Royal Society by William Watson, is not so well known, and does not appear up to the present to have been verified.

We cannot agree with him, I am sure, when he says, "nor is it of much importance for us to know the manner in which Nature executes her laws; it is enough if we know the laws themselves." For the pursuit of the manner in which Nature executes her laws is the distinguishing characteristic of the science of the present day. It has led to most brilliant discoveries, and it bids fair to do more than all other agencies combined to show the intimate and necessary relations existing between the different branches of physics. We need to be reminded often that accumulated facts do not constitute a science, and that utility is not the highest reward of scientific pursuits. A bit of polished marble plucked from the ruins of the Roman Palatine Hill is an interesting relic; but how much more interesting to reconstruct the palace of Nero and to see this fluted marble in its proper and designed relation to the whole of which it was once a necessary part! Science is constructive. Laws are derived from an attentive consideration of facts; generalisations group laws under broader relationships; and great principles unite altogether into one related, impressive whole.

From the time when the famous Boyle caught sight of a faint glimmer of electric light to the present, physicists have been in pursuit of the connection between light and electricity. As early as Newton's time, the ether was conceived by some to be a very subtle medium confined to small distances from the surfaces of bodies, and to be the chief agent in all electrical phenomena. But, says Priestley,[*] "the far greater number of philosophers suppose, and with the greatest probability, that there is a fluid *sui generis* principally concerned in the business of electricity. They seem, however, though perhaps without reason, entirely to overlook Sir Isaac Newton's ether; or, if they do not suppose it to be wholly unconcerned, they allow it only a secondary and subordinate part to act in this drama." Among the branches of knowledge that this writer recommends as likely to be of service in the study of electricity is the doctrine of light and colours.

The invention of the voltaic battery and Sir Humphrey Davy's celebrated experiment in producing the electric arc stimulated enquiry in this same direction. Mrs. Somerville, Morrichini, and others, sought to produce magnetism by means of sunlight, but ultimately, as is now known, without success.

Notwithstanding these negative results, Faraday had such a "strong persuasion derived from philosophical considerations" of a direct relation between light and electricity, that he resumed the enquiry in a most searching manner, with the happy result of discovering the rotation of the plane of polarisation of light by means of magnetism. "Thus is established," he says,[†] "a true, direct relation and dependence between light and the magnetic and electric forces; and thus a great addition [is] made to the facts and considerations which tend to prove that all natural forces are tied together and have one common origin."

It was thus reserved for Faraday to make those discoveries and to obtain that insight into electric and magnetic action which were needed by his great disciple and interpreter Maxwell to construct a most marvellous theory of the connection between these two departments of physical science.

Respecting the failures to obtain magnetism from the direct action of sunlight, to which allusion has been made, Maxwell says that we should not expect a different result because the distinction between magnetic north and south is one of direction merely; that there is nothing in magnetism indicating such opposition of properties as is seen at the positive and negative poles of a battery in electrolysis; that even right and left handed circularly polarised light cannot be considered the analogue of the two poles of a magnet, for the two polarised rays when combined do not neutralise each other, but produce plane polarised light.

It may be said, however, that if a right-handed circularly polarised ray produces magnetism in one direction and a left-handed ray in the opposite, then the combination of the two rays may neutralise their magnetic effect, inasmuch as plane polarised light may have no magnetic influence. Prof. J. J. Thomson has lately shown mathematically[*] that a circularly polarised ray does have a magnetic effect, but that it is so small, even with strong sunlight as to be much beyond the limits of experiment; and Mr. Shelford Bidwell[†] has produced a bar of iron in such an exquisitely sensitive magnetic state that magnetic changes are certainly produced in it by the direct action of light.

This he has accomplished by rendering the bar more susceptible to magnetic influences in one direction than the other. We may not, I venture to affirm, be without hope that magnetism and electric currents may yet be evoked by the direct agency of sunlight.

Faraday was deeply convinced that space has magnetic properties, and that the space or medium round a magnet is as essential as the magnet itself, being a part of the magnetic system. To him all magnetic and electric action took place by contiguous particles along lines of force. "What that magnetic medium, deprived of all material substance, may be, I cannot tell," he says,[‡] "perhaps the ether." No doubt existed in Faraday's mind that these lines of force represent a state of tension; but whether that tension is a static state in the ether, or whether it is dynamic, resembling the lines of flow of a current between the poles of a battery immersed in a conducting fluid, was uncertain. He inclined, however, to the latter view. He was thus led to advocate, though not without hesitation, the physical nature of lines of force.

Faraday's discoveries, and his method of regarding all magnetic and electric actions as propagated through a medium by means of contiguous parts, have been of the utmost productiveness. They have revolutionised the science of electricity, and have been the most potent factors in the genesis of a theory, including all radiant energy, which has recently received such remarkable and conclusive confirmation. His name has become almost a household word. His earnest, unselfish life has added unnumbered millions to the world's wealth. His ideas and words, which have been instruments in the hands of philosophers, have become the current coin of the commercial tyro, who talks as glibly about lines of force and the magnetic circuit as if he really knew something about them.

Fruitful as Faraday's ideas were, they yet awaited a mathematical interpreter for their highest development. A good Providence sent James Clerk Maxwell, whose brilliant mathematical ability was equalled by his philosophic insight, his poetic feeling and imagination, his profound sincerity, and his great sympathy with nature. Hear him sing at Aberdeen:

"Alone on a hillside of heather,
I lay with dark thoughts in my mind,
In the midst of the beautiful weather,
I was deaf, I was dumb, I was blind.
I knew not the glories around me,
I counted the world as it seems,
Till a spirit of melody found me,
And taught me in visions and dreams.

"For the sound of a chorus of voices,
Came gathering up from below,
And I heard how all Nature rejoices,
And moves with a musical flow.

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[*] "Hist. of Elect.," vol. ii., p. 22.

[†] *Exp. Researches*, 2,221.

[*] "Applications of Dynamics to Physics and Chemistry," p. 78.

[†] London *Electrician*, March 22, 1889.

[‡] Exp. Researches, 3277.

Oh! strange! We are lost in delusion,
Our ways and our doings are wrong,
We are drowning in wilful confusion
The notes of that wonderful song."

To appreciate Maxwell's relation to theories of electrical action it is desirable to take a retrospect of the views that have been held regarding its nature. Three periods in the history of these views may readily be distinguished. The first was introduced by Dr. Gilbert in 1600 and it lasted about 225 years. The little that was known previous to Gilbert constitutes only the preface or introduction to the history proper. Nearly three-fourths of this period was utterly barren and unfruitful. It knew nothing better than unctuous effluvia and electric atmospheres. In the latter half of the period the Newtonian philosophy had become the orthodox doctrine. The great success attending the mathematical investigations founded upon the law of inverse squares naturally carried with it the acceptance of the underlying hypothesis of "action at a distance." There were not lacking, indeed, men of deeper philosophic insight who denied this doctrine, which they looked upon as entirely unphilosophical, and which must utterly bar the way to any enquiry into the process by which the law is executed. Action at a distance by attraction or repulsion, varying inversely as the square of that distance, means an ultimate fact not admitting of further analysis.

The second period was one of contention. It began not with the important discovery of current electricity, nor of the electromagnet, but with the philosophical methods and concepts of Faraday. The physical postulates of the mathematical school were entirely alien to the views which he adopted. "Faraday, in his mind's eye, saw lines of force traversing all space where the mathematicians saw centres of force attracting at a distance; Faraday saw a medium where they saw nothing but distance; Faraday sought the seat of the phenomena in real actions going on in the medium, they were satisfied that they had found it in a power of action at a distance impressed on the electric fluids."* Prior to Faraday the supporters of a medium, to explain electric and magnetic action, were always thrown out of court for lack of evidence; Faraday gave them a legal standing by furnishing the facts and evidence on which they could well afford to base their case.

The corpuscular theory of light, which had shown such remarkable vitality, was now in the last stages of a fatal disease due to indigestion and lack of assimilation. Foucault finished it off in 1865 with his crucial experiment to decide upon the relative velocity of light in air and water. The undulatory theory was thus fully established, and the doctrine of radiant energy in general began to be clearly apprehended. The grand generalisation of the conservation of energy was looming up all along the horizon of science, as the towers and spires of a great city appear to rise out of the sea to a traveller approaching the land. Victory was ready to perch on the banners of an army contending for the ether doctrine—not a decimated army, but one constantly augmenting in numbers by deserters from the enemy.

(To be continued.)

THE ELECTRIC LIGHT IN AUSTRALIA.

The *Daily Telegraph* at Sydney has recently erected new and commodious premises, which are lighted solely by electricity. At the opening of these buildings a number of gentlemen were invited to view the place and the arrangements. It is needless here to refer to the general work of a newspaper office. We will confine our remarks to the engine and dynamo-room. The former is entered from the machine-room, and contains two fine semi-portable engines by Fowler and Son. These engines are of 20 h.p. each, and are capable of working up to 70 h.p. They are fitted with Hartnell's patent governors, and with automatic expansion gear on both cylinders, so as to give perfect regularity in working and thus secure steadiness with the electric light. These engines are also cross connected, so that the steam from one may be turned into the other and *vice versâ*. Large piping communicates from one boiler to the other, and the advantage of this connection is easily explained. Supposing one engine to break down when in full steam, the power is not wasted, for the steam from the boiler of the disabled engine may be turned into the other engine and thus utilised. These engines may be run together or separately.

From the engine to the dynamo-room is but a step. The installation is by Crompton and Co., of Chelmsford, and it was fitted up by Harrison and Whiffin, Australian agents for the company. There are two dynamos. One of them is capable of carrying 400 incandescent lights, and from this the whole office is lighted direct. The other is an arc light machine, and it runs the powerful arc lamps situated immediately in front of the building. This latter machine will also be used for charging the accumulators, which will contain six hours' supply, so that in the event of any accident to the machinery the office will not be left in darkness. There is no gas on the premises, the management depending solely upon the electric light and the completeness of their general arrangements in connection therewith.

It will be as well to state concisely the provision made. In the first place, there are the duplicate engines previously spoken of, both of which are connected with the electric lighting apparatus and either can be run independently of the other. One may be thrown out and the other into gear immediately. The machine used for charging the accumulators may be worked if required. It would therefore be necessary for two engines or two dynamos to break down to seriously interfere with the electric lighting of the establishment. Even then there would be the six hours' supply in the accumulators to fall back upon, and it is only reasonable to suppose that during the six hours thus provided for any accident to the machiney could be repaired. Consequently, it will be seen that it will require an extraordinary combination of adverse circumstances to totally deprive the offices of the electric light even for a short space of time.

There is another advantage in connection with this storage, and that a most important one. Supposing the weather to be particularly dull, and it is found necessary to light up the basement. Having the accumulators, there will be no occasion to start the machinery to run the dynamos. On Saturday night, too, when business is carried on only in part of the building, there will be no need to work the electric light plant, the accumulators again providing for the illumination.

The wires in connection with the electric light installation have been put up strictly in accordance with the rules of the fire office, and they are equal to carrying twice as much current as the dynamos can give.

NEW COMPANIES REGISTERED.

Wrexham and District Electric Supply Company, Limited.—Registered by Abbott, Jenkins, and Co., 9, New-inn, Strand, W.C., with a capital of £20,000 in £5 shares. Object: to form centres in Wrexham or within the surrounding hundred of Bromfield at which electric power may be generated and distributed. Registered without articles of association, and consequently the regulation of table A in the first schedule of the Companies' Act, 1862, apply.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The receipts for the week ended December 27 amounted to £5,027.

West Coast of America Telegraph Company, Limited.—The Directors of this Company have declared a second interim dividend of 5s. per share in respect of 1889, tax free, payable on the 9th inst.

United River Plate Telephone Company, Limited.—The Directors have declared an interim dividend for the half-year ending September 30 of 2 per cent. (being 2s. per share), tax free, payable on the 15th inst.

Western and Brazilian Telegraph Company, Limited.—The receipts of this Company for the week ended December 27, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,683.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Anglo-American Brush	—	3
— Pref.	—	2
India Rubber, Gutta Percha & Telegraph Co.	10	17¾
House-to-House	4½	5
Metropolitan Electric Supply	—	
London Electric Supply	5	4
Swan United	3½	5
Telegraph Construction	12	45
— 6%, 1889	100	105
National Telephone	5	6¼

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* Maxwell's "Electricity and Magnetism," p. 10.

NOTES.

Zanzibar Cable.—It is rumoured that the telegraph ship has broken the cable in laying it between Zanzibar and Mombassa.

Hennebont.—The French Minister of Agriculture lately opened the central electric station at Hennebont (Morbihan). The light gives great satisfaction.

Beverley.—A motion by Mr. Arnott before the Beverley Town Council with respect to the lighting of the town by electricity was not seconded. The matter will be brought up again.

Indian Telegraphs.—The advisability of putting the Indo-European and the Indian telegraph systems again under separate administrative heads, either being enough to employ a chief of its own.

Ship Lighting.—The "Pelican" sloop is leaving for the West Indies. At Bermuda she will join the squadron and go into the dockyard to be fitted with her electric light gear which she is taking out with her.

Boston.—The Boston (U.S.) Board of Underwriters has petitioned the Mayor and Council to make an appropriation to remove the vast collections of dead overhead wires, and to systematically regulate all electric wires in use.

Death from Morphia.—Mr. J. M. Holst, engineer and electrician of the Great Northern Telegraph Company, and who has lately been acting as manager in Shanghai, has died in his fortieth year from an overdose of morphia.

Swansea Tenders.—The Swansea Town Council have resolved to appoint a sub-committee to prepare specifications and receive tenders for the purpose of lighting by electricity the streets in Schedule A of the Swansea Lighting Order.

Anglo-American Telegraph.—Mr. Charles Burt has retired from the firm of Bircham and Co., and from practice as a solicitor. He has been appointed a director of the Anglo-American Telegraph Company, in place of the late Sir Daniel Gooch.

Electric Tramways at Hanover. — Messrs. Hostman et Cie. have applied for a concession of four new lines of tramway at Hanover. Inside the town it is intended to use electric traction, which will be changed outside the town to steam traction.

Royal Meteorological Society.—The annual general meeting of the society will be held at 25, Great George-street, Westminster, on Wednesday, the 15th inst. The president (Dr. W. Marcet, F.R.S.) will deliver an address on "Atmospheric Dust," which will be illustrated by a number of lantern slides.

Schanschieff Battery.—An extraordinary general meeting of the Schanschieff Electric Battery Syndicate, Limited, was held on Monday at the offices, 44, Basinghall-street, E.C., for the purpose of considering a resolution for the voluntary winding up of the company and the appointment of liquidators. Representatives of the press were not admitted.

Spain.—An international bureau for matters connected with electricity has been established at Guadaljara. Those who wish to know of electrical work in Spain, and to spread a knowledge of their goods, catalogues, etc., or extend their Spanish connection, should address, with envelope for reply, the Director, M. J. Diaz, 107, Plaza de Jaudennes, Guadaljara, *Spain.*

Stockport Combats the Orders.—The Mayor of Stockport and Colonel Turner, together with the Town Clerk, went as a deputation to call on Sir Thomas Bloomfield with respect to electric lighting. Several companies were applying for provisional orders, and it was thought necessary for the Council to combat these orders. The interview was reported as satisfactory.

Electric Traction.—The *Daily News* has a long and appreciative article upon the electric tramcars now working on the North Metropolitan Tramway Company's line at Barking-road, Canning Town. It states that the Liverpool tramways will shortly be fitted, and incidentally hints that the Electric Traction Company will shortly be coming out with a capital of half a million to deal with the coming work in electric storage cars.

Edison Station Burnt.—The down town station of the Edison Electric Lighting Company of New York caught fire on Thursday last week, and was completely destroyed, resulting in a loss of 100,000dols. The station occupied two four-storey buildings, and supplied electricity to 18,000 incandescent lamps. The fire started in the dynamo-room, but how it broke out is unknown. It was the intention of the company to rebuild the station in the spring, making it fireproof.

Brussels.—In a recent meeting of the Communal Council of Brussels, M. Janssen, director of public works, announced that the electric light would be installed in Brussels by the end of the year 1890. The town will reserve for its municipal station a zone of a quarter of a mile radius from the Market-place. This area comprises nearly all the theatres, the largest shops, as well as the boulevards of the centre of the town—in a word, the whole of the most profitable quarter for an enterprise of electric lighting.

Municipal Station for Ayr.—The Ayr Town Council have obtained from the Board of Trade a provisional order for lighting the burgh with electricity. The compulsory area embraces High-street, Newmarket-street, Sandgate-street, the New Bridge, and Main-street (Newton). The order provides that the mains for wires be laid within two years, and that the undertaking might be transferred to a company. £6,000 is the sum named as necessary for starting the work. This can be increased as the area of lighting is enlarged. A committee is considering the subject.

Communication with the Far West.—The completion of the Canadian Pacific Railway's telegraph lines between Montreal and Canso practically gives Canada an Atlantic cable of her own, connecting as those lines do with the Commercial Cable at the latter point, and rendering unnecessary for the future the roundabout telegraphic route by way of New York. The company now possesses wires from the Atlantic to the Pacific, and such an important saving in time is made, says the *Financial News*, that this means of communication is bound to be used in future for all telegraphic business between Europe and Canada, and a large part of the business with the Far West.

Train Indicator.—A new indicator for watching the progress of the trains has been invented by Prof. Pico, says *L'Ingenieur Conseil.* A wire is placed along the line with an interruptor at each half kilometre or half mile as desired. The train in passing breaks the contact and opens the circuit. At the station a dial face would be placed, divided into as many sections as the line has interruptors.

The dial would also bear the stations, and show their respective distances. The mechanism consists simply of a step-by-step electrical movement, and the needle of the dial advances as the train advances, showing at the head office both the position of the train and the times of arrival and departure.

The Late Charles Lever.—We regret to notice that Mr. Charles Lever died on Sunday at the house of his father, Mr. Ellis Lever, Colwyn Bay. The deceased arrived on Saturday to visit his father, who had been ill for some time. On going to bed Mr. Charles Lever appeared to be in his usual health, but in the morning he was found dead in his bed. The cause of death is stated to be heart disease. Mr. Charles Lever was well known in the electrical world, and had invented dynamos and arc lamps. He travelled extensively through the States, and had some experience in installations connected with collieries. Mr. Lever was a member of most of the electrical societies of Europe and America.

Private Stations at Leeds.—While the Leeds Corporation are busy considering what is to be done, several private firms, who seem to have become tired of waiting to see what the Corporation or the electric lighting companies may do, are setting about providing themselves with the new light. One of the most extensive of these private undertakings is that of the Trevelyan Hotel Company, who propose a few weeks hence to illuminate inside and out all the buildings extending from Briggate to a point near to White Horse-street, on the south side of Boar-lane. Engines of from 16 h.p. to 20 h.p., and the requisite dynamos and other machinery are being placed in the basement of the hotel, and the work of laying the wires is in an advanced stage.

Keswick.—The Keswick Electric Light Company commenced their supply of the light to the consumers in the centre of the town and at the Keswick Hotel on Monday last. The trial went off without a hitch, and the light was steady and bright, and gives the greatest satisfaction to the consumers. The station will now be run every night. The Keswick central electric station is interesting to electrical engineers as being the first public central station in England to be run by means of water-power. The power in this case is supplied by a "Victor" turbine fixed in the wall of the station horizontally, and fitted with countershafting. The station has been carried out under the superintendence of Mr. Edward Cowan, of Messrs. Fawcus and Cowan, engineers, Chester.

Messrs. Poole and White.—The new firm of this name who have started in Bread-street, Cheapside, are laying themselves out for wholesale electrical supplies. They are not inexperienced in this direction, although their names are not yet well known as a firm. Mr. T. G. Poole has been manager of the supply department of Messrs. Woodhouse and Rawson for some years, and Mr. W. White has also lately been for several years with the same firm, being the inventor and joint patentee of the "G" and diamond switches lately brought out, and was the manager of their switch department. The firm have secured some good roomy premises, and we saw on our visit some very useful and neat designs for ceiling roses and switches, of which they are making specialties.

Westinghouse Arcs.—The Westinghouse Electric Company, says the New York *Engineering News*, is introducing a newly-patented system of electric lighting by arc lamps. The dynamo is constructed to deliver the required number of amperes whether the machine is supplying one lamp or its full load, and a short circuit cannot destroy the armature by overheating. The dynamo is automatic in regulation. The lamp is entirely new in design and superior in efficiency to the lamp in use; the carbon lasts for three nights, and the mechanism is very simple. It is so connected in the circuit that it will not transmit a shock to a person coming in contact with it, and lamps varying from 600 to 5,000 c.p. can be operated on the same circuit.

Electricity in Agriculture.—The electric light has been adopted in the agricultural work of the department la Somme, France. The Assainvilliers Farm comprises, besides granaries, stables, etc., a distillery, which works night and day. Before the introduction of electric light petroleum was used, at a cost of 13½f. a day. At the present time the whole of the buildings are lighted with 48 incandescent lamps of 20 c.p. The dynamo is driven by a 5 h.p. engine already on the premises, and the cost of running, without counting interest or depreciation, is only 9f. per 24 hours, comprising engineman 3f., and coal 6f. The saving of 4½f. per day in three years will pay the whole cost of the installation, which was fitted for 3,500f. (about £150). The example is likely to lead to extension of the employment of electric lighting in agricultural operations in the department.

Incandescent Lamps as Hat Irons.—A useful domestic discovery is announced in the New York *Electrical Review*, being no less a one than that you can iron a silk top-hat with an incandescent lamp. An enterprising young electrician in Washington, recently married, who had occasion to spend the evening down town with some friends from New York, was shocked to find, as he was about to go home, that his new silk hat had, in some unexplained manner, become badly rumpled. Shops that "block your hat while you wait" had longed been closed and, for a moment, Benedict was in distress, but his ingenuity did not fail him. Stepping into a restaurant lighted by electricity, he soon found an incandescent lamp attached to a long flexible conductor, and with this he deftly and quickly ironed out the wrinkles from his battered tile and hastened home to his waiting wife.

Rival Companies at Newcastle.—At the Newcastle City Council, on Tuesday, in answer to a question as to whether the Council was not creating a great monopoly by allotting certain streets to each electric lighting company, Mr. T. B. Winter said the Corporation had not allotted certain streets to either of the electric companies, and consequently there was no monopoly created. The Town Improvement Committee presented a report relative to an application to the Board of Trade by the Northern House to-House Electricity Company, Limited, for a provisional order authorising them to supply electricity within the city. The committee did not think it desirable that a third company should supply electricity to Newcastle. They therefore recommended that the requisite objection be served to the Board of Trade. Alderman Newton was not sure that they should object to a third company. On the motion of Alderman Hamond, it was agreed that objection be lodged with the Board of Trade in order to establish a *locus standi*, and that in the meantime the report stand over.

The Federated Institution of Mining Engineers. This newly-formed organisation, which has a membership of 1,250, has fixed upon Sheffield as its first meeting-place. The general business will be transacted at a meeting to be held at the Royal Victoria Hotel, on the 22nd inst., when the following papers will be read: "On the Geology of the Yorkshire Coal Field," by Mr. R. Russell, F.G.S.; "On Coal-getting by Machinery," by Mr. G. Blake Walker; and "On Electricity as applied to Mining Operations," by Mr. Albion T. Snell. Among the places the members may visit are—Messrs. Locke and Co.'s St. John's Colliery, Normanton (electric power applied to underground operations); Messrs. Bower's Allerton Collieries, Woodlesford, near Leeds (colliery machinery driven by electricity); and the Wharncliffe Silkstone Colliery (machines driven by compressed air). The programme embraces a reception by the Mayor and Master Cutler of Sheffield at the Cutlers' Hall, where a mining exhibition will be held. On the 23rd there will be visits to works and collieries in the neighbourhood.

Clermont-Ferrand Electric Tramway.—An electric tramway has been constructed at Clermont-Ferrand, Puy-de-Dome, France. It connects the railway station with thirteen points of the town, the distance between the extreme stations being seven kilometres—about 4½ miles. The current is generated at a central station, and is conducted to the motors by overhead wires. The plant at the station comprises a steam-engine of 150 h.p. which drives a Thury six-pole dynamo separately excited, giving 300 volts and 350 amperes at the speed of 375 revolutions. The exciter, which also serves to light the station, is driven by a separate steam-engine of 24 h.p., at the speed of 1,200 revolutions, giving a pressure of 75 volts. Each tramcar carries a Thury motor of 40 h.p., provided with a reversing switch. The current arrives by the overhead wires, and returns through the rails to earth. The ordinary speed of the cars is 7½ miles an hour. Our information does not state the price of each fare, though it is mentioned that 1cwt. of luggage can be carried with the passengers at a charge of 2½d. extra.

The Late Francois Despointes.—Another well-known voice is lost, and the well-known features will be seen no more. Mr. F. Despointes was in some measure more English than an Englishman, but all through his long residence among us he never lost the delight of mixing with his fellows. It is our national characteristic that we can take our pleasures alone, but our late friend was never so happy as when meeting his *confrères* at one of the many meetings which are held during the winter months in this busy metropolis. One of the old school, gentle, thoughtful, and kindly by nature, systematic in his duties, a friendly greeting and a ready smile endeared him to many who were used to the younger and more flighty generation. For many years he was engineer to the late Submarine Telegraph Company, and we believe had preferred to continue working rather than accept a retiring fee when the company was taken over by the Government. The hand of death has sadly thinned the ranks of the older telegraph men, around whom exists the halo of pioneers, and none will be more missed than our old friend, François Despointes.

Coventry.—At the meeting of the Coventry City Council held last week, the following report from the General Works Committee was presented: "Your committee beg to report that on November 30 last the solicitors to the Midland House-to-House Electricity Company, Limited, deposited with the town clerk advertisement with plan of their intended application to the Board of Trade, on or before the 21st inst., for a provisional order to produce, store, sell, and supply electricity for all public and private purposes within and throughout the city, and your committee recommend the Council to oppose the proposed provisional order, and to refer the whole matter to this committee with full authority to this committee to take all such measures as they may think fit in reference to the matter of such application, and proposed provisional order and opposition thereto." In the discussion upon this report it was stated that not upon any wish to obstruct the progress of the electric light, but from the wish to keep the management of the roads as now on the hands of the Council, it would be better to oppose the application. The report was agreed to.

Mechanical Punkah-Pulling.—An Indian contemporary asks whether some inventor cannot tell us how to make a cheap and efficient mechanical punkah-puller for use in India and the tropics generally? It ought not to be a very difficult problem to tackle. The human agency at present employed, though fairly cheap, it says, is not very efficient. The punkah-puller at night has an awkward way of stopping work as soon as he thinks his employer is asleep. A machine could be relied upon to keep the cool fan going all night. There would be a very large field for such an invention, for it is said that in and around Calcutta alone there are 28,000 coolies—a most appropriate word in this case—earning their living by pulling punkahs, and the Government spends 740,000 rupees a year on punkah-pulling in the barracks. The *Indian Engineer* says that much depends on what is meant by "cheap" and suggests a gravity and escapement motor, three or four of which could be wound up by one coolie. We should have thought that this would prove an immense field for the introduction of small electric motors if the right person could be got hold of to introduce them into the Government quarters.

The Gasman Saved.—From what we hear, it was only just by an accident that a zealous servant of its rival did not fall a victim to electricity from his own stupidity. Down the Strand comes Lucas Logan, of county Tipperary, gasman, with a steel prodder in his hand, his business being to find gas-pipes. An electrical engineer, who was passing the spot, heard the tap tap of the prodder with a metallic sound and turned to see. The prodder was knocked violently on one side. "What the dickens do you want there? Do you know what that is?" "No," said the astonished gasman, "just what I was a-thrying to foind out." "Well," said the other, "that's an armour-plated electric cable with 5,000 volts inside it; you're just *trying* to get killed, that's what you're doing—sticking your prodder into an electric cable." Our gasman turned absolutely pale with fright and gasped, "Oi could see it wasn't a gas-pipe." It would take more than gentle prodding to get through the armour plating, no doubt, but there's no knowing what an ignorant and curious gasman with a prodder would do. He will probably warn his mates not to prod odd-looking cables in a trench after this.

Salzburg.—The central electric light station at Salzburg, Austria, is interesting from the fact that the dynamos are intended to be run by day for a mountain railway. The station is established near the River Salzbach, which runs through the town. It contains two steam-engines, of 30 and 60 h.p., which drive three Siemens and Halske dynamos, of 140 volts and 125 amperes, at 940 revolutions, shunt-wound, the exciting circuit being shunted from the switchboard instead of, as usual, from the brushes of the machine. The distribution is effected by feeders at

120 volts to allow arc lamps to be run two in series. The cables are on the concentric system, and are armoured. The station at the present moment only supplies some 500 lamps, but is constructed for a supply of 1,200 lamps. The price of supply is given as 10 centimes per hour. It is proposed, in order to utilise the dynamos during the daytime, to establish an electric railway to the summit of the Monschberg, a well-known resort of tourists. Some 18 h.p. will be sufficient for this work, and a single dynamo at the station will be able to supply the necessary current.

Northampton.—A communication was brought before the Northampton Town Council asking their consent to a provisional order authorising the Electric Lighting Company to supply the electric light within the municipal area of Northampton. The town clerk reminded them that the consent of the Council had been given to a license for the company. The provisional order, however, was for a longer period, and was, therefore, of greater importance than the license. According to his present impressions the order gave very great security to the public, as much as has been discovered up to now. But fresh dangers, also, were being constantly found out with regard to the transmission of electricity, and further securities invented. Therefore, he could not advise the Council to give their consent to the provisional order, because the company did not need the consent, and because by giving it the Council tied their hands and closed their mouths before the order had been discussed. He suggested that the Council acknowledge the receipt of the communication, and make no order upon it, but reserve the right so to do. This was carried.

Rapid Telegraphy.—A new system of rapid telegraphy is described in the *Scientific American* for December 28, 1889. The new features are the high speed—2,500 revolutions and about 500 words per minute; the method of "visual" synchronising; the system of characters which, by means of a number of straight or curved signs, form actual letters on the receiving strip. The synchronism is obtained by means of a spark, which is visible to the attendant. This spark occurs on the rim of a revolving flywheel, of which the counterpart is at the further end, the passing of a current through a relay breaks the primary circuit of an induction-coil, and the impulse in secondary causes the spark. When the two wheels are synchronous this spark appears to stand still, but when they vary it either advances or retrogrades; the speed can be regulated by a small brake. The messages are punched in a type-writer and transmitted, the tape at the receiving end being in characters to all appearance like ordinary type. The invention appears a valuable one and the system has been tested between Washington and New York. It is the invention of Mr. J. Harris Rogers, and is being introduced by the Visual Synchronism Company at 34, Broadway, New York.

Standardising and Training Institution.—We mentioned briefly last week the fact that the old Hammond Electrical College was to be revived, and some particulars were given in a contemporaneous advertisement. We have now received the prospectus of this undertaking, which is to be known as "The Standardising, Testing, and Training Institution." The prospectus is fitly introduced by a number of testimonials to the usefulness of the training received at the original college by men who are now chief engineers, managing directors, members of electrical firms, or electricians in various capacities, whose progress was started by a course at the college. It will be noticed that the board of control, besides Mr. Robert Hammond, the founder, include Lord Crawford, Hon. Reginald Brougham, Mr. Francis Ince, and Mr. Hugh E. Harrison, B.Sc. The latter, who was principal of the old college, has again been secured in that capacity. The engineering department is under the charge of Mr. William Lowrie and Mr. H. H. P. Powles, A.M.I.C.E.; chemistry, Mr. C. J. Wilson, F.I.C.; mathematics, Mr. Alexander Russell, M.A.; secretary, Mr. Philip A. Latham, M.A. The laboratories and workshops are situated at Charing Cross, and are connected to the mains of the London Electric Supply Company, and a constant supply of current will be available—up to 2,000 h.p. if necessary—for standardising and testing. The institution, besides these purposes, will undertake the training of electrical engineers, the fees being 100 guineas a year. The prospectus very truly says, "When it is remembered that to every electric supply station and to every electrical manufacturing works must be attached a competent staff of electrical engineers, and that under the Electric Lighting Acts duly qualified inspectors have to be appointed, it is needless to say that for many years the electrical engineering profession will probably offer a larger field for employment than that of any existing industry." It is the intention of the institution to affiliate with the principal electricity supply companies, and with firms of good standing, to afford the students opportunity of seeing and eventually engaging in actual practical work. The course will begin on the 19th February next. The secretary's address is 15, St. Helen's-place, E.C.

The Taxing of Telpher Tramcars.—Before Messrs. J. McCall and S. L. Stacey and Major Taylor, the divisional justices sitting at the Edmonton Petty Sessions on Saturday, the Mines and General Telpher Company, Limited, of 12, Great George-street, London, appeared to answer a summons, issued at the instance of William Leghorn, officer of Inland Revenue, for having on August 17, at the parish of Wood Green, kept five carriages, for the keeping of each of which a licence was required by the statute, without having proper licences. Mr. Robinson, who conducted the prosecution, said the case was an important one from the point of view of the Inland Revenue authorities, because it was the first case of the kind which had been brought forward in the neighbourhood of London, if not over the whole of the United Kingdom. The company was charged with having an electric tramway, and running thereon five carriages carrying passengers from the entrance to the Alexandra Park to the doors of the Alexandra Palace, the carriages being unlicensed. Mr. Christie, of Messrs. Lee and Pemberton, who appeared for the defence, said his clients considered that their line was a railway, and they did not wish to avoid the payment of any duty for which they might be held liable by the Bench. This was a new invention, and they wanted to find out what they were really liable for. He contended that his clients' cars did not come under the definition of a carriage, because they did not ply for hire, and could not be stopped like a tramcar between the fixed stations. He thought it was not a case in which a penalty should be inflicted inasmuch as it was a test case, and there was no intention to evade liability. The clerk of the court (to Mr. Robinson): What do you do in the case of switchback railways? Mr. Robinson: They don't run on wheels. Mr. Christie: Oh yes they do. Mr. Robinson: No. I think they run on smooth rails. Mr. Christie: You are thinking of tobogganing. The chairman of the Bench, after a consultation lasting several minutes, said they were disposed to find that the carriages referred to in the summons did not come within the definition of a carriage subject to taxation. The Bench thought it was a sufficient reason of exemption that they ran on rails, though it was not a statutory railway. Mr. Robinson intimated that the decision would be appealed against.

Torquay.—At the meeting of the Torquay Local Board last Friday, Sir Edmund Hornby presented the report of the special committee appointed to consider the question of the lighting of Torquay by electricity, as follows: In view of the fact that two companies—viz., the Devon and Cornwall Electricity Supply Company, and the Municipal Electric Light and Power Corporation—have applied to the Board of Trade for provisional orders for lighting the area of the district of the Board, and of the shortness of the time allowed to the local authority—until the 1st of February, 1890—to make any representation to the Board of Trade or bringing before them any objection respecting such applications, your committee deem it advisable to postpone any attempt at making a general and comprehensive report on the whole subject bearing on the expediency or mode of lighting Torquay by electricity, and without delay to present an interim report with reference to the course to be pursued by the Board under the circumstances of the two before referred to applications. Your committee are of opinion that in the abstract it is desirable the electric light should be introduced into Torquay, but that, from the character of replies to enquiries made of other towns where electric lighting has been adopted—the experimental nature of existing systems, and the discussions still proceeding in reference to the danger connected with giving a large supply—it is very desirable that some further time should be allowed the Board to consider the whole question before coming to any conclusion as to the new method of lighting. It is possible that, when further enquiries have been made, the committee may come to the conclusion that the Board themselves should undertake the electric lighting of the town rather than that any outside company should obtain powers for that purpose. Your committee, therefore, recommend that, with a view to prevent the companies in question proceeding with their applications and obtaining parliamentary powers, the Board should not give their consent as required by the Electric Lighting Act, 1888, to the application of either of the companies seeking for provisional orders, and that the Board give authority to your committee at once, with the assistance of the law officer of the Board, to formulate such objections as it deems most likely to defeat the proposed grants of the provisional orders alluded to, and that such objections be sent in and representations made to the Board of Trade in the usual manner, and that the law officer be authorised to employ Messrs. Batten and Company as parliamentary agents to represent the Board. On the proposition of Sir E Hornby seconded by Mr. Appleton, the report was adopted.

St. Pancras.—The St. Pancras Vestry are evidently intending to be the first in the metropolis to carry out its own central station for supply of electric light. The Vestry is one of those authorities who in 1883 obtained a provisional order for electric lighting, and on Wednesday last week a special meeting of the Vestry was held to consider the unanimous recommendation of its Lighting, Parliamentary, and General Purposes Committees to carry out an installation of electric lighting under that order. Previous to the report being presented, a notice of motion by Mr. Beswick was taken into consideration—viz., "That the Vestry call a meeting of ratepayers before deciding for or against electric lighting." Upon a vote being taken this was negatived. Mr. Councillor Westacott then submitted for approval the following recommendations: (1) That it is expedient, in the interests of the parish, that the Vestry should take steps forthwith to put in force the provisions of the St. Pancras Electric Lighting Order. (2) That in the first place it is desirable to secure a site and carry out one installation for the supply of electricity for public and private lighting, and for motive power, such site to be of sufficient area to allow of extension. (3) That the site obtained should be so situated as to form one of several sites, and so part of a complete scheme for the whole parish, which scheme will require, say, one installation in each of the four parliamentary divisions. (4) That it is desirable to carry out the first installation, in view of the complete scheme with several stations hereafter, inasmuch as such scheme will be attended with the advantage of enabling each station to supplement the others in case of temporary need. Your committee therefore recommend (*a*) That your committee be authorised to obtain plans, specifications, estimates, and tenders for carrying out a first installation for the supply of electricity for purposes of light and motive power of an extent sufficient for, say, 10,000 incandescent lights, of 16 c.p. each, and 90 arc lights. (*b*) That the premises in Edward-street, belonging to the Vestry, be (if possible) appropriated for the purposes of this installation. That authority be given to the committee to further employ Prof. Henry Robinson, C.E., for the purpose of preparing the necessary plans, specifications, and estimates, assisting in obtaining tenders, and superintending the carrying out of the first installation; that he be paid for his services at the rate of 4 per cent. on the amount of his estimates for such first installation, such commission to include all personal services and assistance, and that in the event of the Vestry deciding not to proceed upon the tenders, he be paid one-half of such commission in full settlement of all claim for services from June 30 last, the date of the last settlement, such engagement to be subject to a proper agreement being entered into between the Vestry and Prof. Robinson. Your committee feel that it may be necessary to call in some consulting electrician, and your committee recommend that authority be given to them to call in, if they deem it necessary, Dr. Hopkinson, or some other electrician of great eminence, as a consultant, so as to have a second professional opinion upon any plans, specifications, estimates, or tenders, or upon the carrying out of the works. A lengthy discussion ensued, a minority of the Vestry fighting each paragraph with amendments, but the report was eventually adopted on a division by a large majority. The installation contemplated will involve an outlay of about £60,000. Considerable importance attaches to this proceeding. The St. Pancras Vestry is the only one in the metropolis, so far as yet appears, that is going to carry out its own electric lighting, private and public. By this course of action, in undertaking its own electric lighting and opposing the admission of any electric lighting companies into their district, the Vestry preserve all the profits of this method of illumination to the ratepayers. The proceedings will be watched with great interest.

THE BRUSH COMPANY.

A brilliant assemblage of scientific and business men met around the festal board at the Metropole on Monday evening last, at the invitation of the chairman and directors of the Brush Company, to celebrate the tenth anniversary of the formation of the company, and to inaugurate the new, short, and less cumbrous title that the company is in future to be known by. We do not intend to enter into any great detail as to the dinner itself, or the numerous guests; suffice it to say the first was admirably served, and the latter included almost every name of repute in the rolls of the industry, and the learned societies were also largely represented. Sir F. Bramwell in his inimitable manner, when entrusted with the toast of the evening, suggested that the Brush Company followed the footsteps of Royalty, and had a real anniversary of birth, while another day was selected to keep it. Thus the real anniversary of the birth of the Brush Company was in December last, the day kept was in January. Now, a good deal may be written about the Brush Company, from its inception, ten years ago, to the time of its anniversary kept this week. We must be content with a very brief *resumé* of its history. Started to work the Brush interests in this country, with a machine adapted for arc lighting and arc lamps, both machines and lamps having, up to the present, held their own for this particular class of work, it was found, however, that there was not the same opening here as in the States for arc lighting, and therefore attention was directed to the production of a machine for incandescent lighting; this terminated in the design of the Victoria dynamo, which we believe is admitted to be an improved Schuckert—the improvements having been made by Mr. Mordey. A start was made in the manufacture of incandescent lamps, but litigation between the company and the Swan Company, after a hard fight, led to the arrangement being made between these companies which now holds. The further development of electric lighting, especially for central station work, led to close attention being given to the merits of alternators and transformers, and the Brush Company was again well to the front in producing the Mordey alternator and transformer. Great attention has also been given to the question of transmission of power, a direction in which this company is now doing good work. Thus we see, from this rapid review, that the company from its birth has never ventured to stand still, but has always been among the first, if not the first, to grasp suggestions likely to live, to work at them, and to introduce apparatus of the best and most efficient modern type. If we were asked to give a reason for the success of the company, we should say it was from having cultivated a strict attention to business. The construction of machines that cannot be commercially a success is not attempted—efficiency and economy being the watchwords that rule the business. Sir F. Bramwell, who at the dinner stated that he had hitherto been annexed to the opposition camp, was feign to confess to the admirable manner in which the business had been carried on. In replying to the toast of "The Electrical Industry," if we heard aright, Sir J. Pender stated that sixty millions of money were invested in cables. This is a large sum; but we venture to think that ere the Brush Electrical Engineering Company is ten years older the amount invested in electric lighting and power work will far exceed this amount, and we are quite sure the "Brush Company" will benefit as much as any in the increased or increasing development of the industry. Whispers are heard of going too fast. It may be that such is the tendency, but you cannot go too fast in the right direction, in the doing of good, sound work, though in other directions mistakes will probably be made. However, it may be some consolation to those who dread the pace to know that the public are exceedingly cautious, and are more than careful to examine the statements put before them.

We trust that the success of the company under the new title during the next ten years, will be in more than geometrical progression to what it has been during the past ten years, and that the extensions added to it may justify by the result the expectations of the directors. If tramway work and the transmission of power is to develop, this company will be in the position to meet all demands, having not only well-organised electrical works, but well-organised engineering works.

ELECTRIC WELDING.

When is welding by electricity to become a practical method in this country? Is it to remain an exhibition experiment, beloved of scientists but shunned by manufacturers, or is it, indeed, to become an extensive benefactor to the industries of England? These, we take it, are questions that must have occurred to engineers, both electrical or otherwise, and they are questions which we think will shortly be answered in a very satisfactory manner to both parties, for it can hardly be denied that the accounts we hear of the progress of this new branch of electrical work from America, and the manner in which events are shaping themselves in this country eventually mean an entire change in our methods of dealing with the working of metals.

The process of welding by electricity invented and developed by Prof. Elihu Thomson is, in America, worked by the Thomson Electric Welding Company. This company is quite distinct from the Thomson-Houston Electric Company, of which also Prof. Thomson is joint patentee, although the two companies, no doubt, are friendly, and, to some extent, work together. The Thomson Welding Company have already large works established at Lynn, Massachusetts, with some hundreds of men at work manufacturing the various types of welding machines, and these machines seem to be rapidly taking a position as a recognised part of the equipment for many industries. Chains are made by the aid of the electric welder, from the delicate work of a jeweller to the massive rings of the large cable chains; carriage-makers use the process for welding the axles of carriages, the tires of wheels, and for other similar work. Wire cable is another industry which promises to engage largely in the new method of welding; the various wires of the cable are welded together homogeneously and quickly, and one celebrated maker of this class of goods states that he has already made 80,000 welds by electricity with the best results. Copper can be welded to copper without the trouble of brazing or the loss of conductivity incident thereto, a point of considerable importance in the construction of electric conductors; tubes, such as those for hydraulic mains, are equally well manipulated, with joints to stand the high-pressure water and with no inequalities in the interior of the tube, in an eminently satisfactory manner; while that most troublesome of engineering problems, the rivetting of boiler plates or girders, has equally well been performed by means of the electric welder.

The patent rights for England in the electric welding processes of Prof. Elihu Thomson have been purchased by a group of capitalists representing financial and engineering interests, under the name of the Electric Welding Syndicate, who have taken offices for the present at 2, Laurence Pountney-hill, E.C. Mr. Ewing Matheson, C.E., of Messrs. Matheson and Grant, engineers, 32, Walbrook, is consulting engineer to the syndicate, who have undertaken to determine the actual possibilities at present of the process, and its future capabilities; to institute practical tests and applications in England, and to present them before acknowledged engineering authorities and the manufacturers most interested. As a first step in this direction they have resolved to obtain an independent report of the best and most reliable character, and for this purpose have fortunately been able to secure the services of Prof. Alexander B. Kennedy, late of the University College, London, who has gone over to America to investigate the present state of the electric welding process as now practised, and to report thereupon, and Prof. Kennedy's report will be awaited with great interest from all classes in the engineering world. The Electric Welding Syndicate have also taken premises in London, near the City, at 71, Fanshawe-street, Hoxton (Shoreditch Station, or by tram from Moorgate).

At these works the various welding machines can be seen in operation, and a demonstration was given on Tuesday by Mr. W. Fish, of the Thomson Electric Welding Company. A semi-portable engine drives two Thomson-Houston dynamos—an alternate-current machine used for supplying the current to the welders, and an exciter. A resistance placed in the shunt of the fields of the exciter serves to regulate the strength of the current supplied to the welding machines, and is placed close at hand for the person who is welding. Different machines to the number of five are shown at the works for demonstrating the method of welding from small wires up to thick bars of iron or steel of some 2in. diameter.

The small machine for wires has an ingenious arrangement for both regulating the amount of heat and for cutting off the current when the weld is complete, rendering the action automatic. The wires to be welded are each fixed in a small screw clamp; the amount of wire left projecting varies according to the diameter of the wire, different lengths of projection from the clamp being given to allow for the conduction of the heat away by the clamps themselves. This is regulated by a small wheel having studs of various lengths projecting from it; the wheel is revolved, and a stud suitable for the wires to be welded is selected and placed between the clamps, thus keeping them at the right distance apart. The wires to be welded are then inserted and screwed down, and the stud-wheel is then throw back out of the way. The two wires then come together opposite each other, end to end, ready to weld. The duration of the weld is regulated by an ingenious spring switch, as follows:

A switch-handle, which can make or break the circuit, is pulled over, making connection. It has a spring, which tends to pull it back and break connection, but is kept in place by a stud. When the wires heat under the action of the current, they become, of course, soft for the moment. They are pressed slightly together, completing the weld, and this slight movement releases the stud, and the switch-handle automatically flies over, cutting off the current at the exact moment of completion of the weld, without attention on the part of the operator. The regulation of the strength of the current for this welder is obtained by a separate piece of apparatus, which is in reality an induction-coil in the main circuit to the welder. A movable handle allows a heavy solid copper ring to be moved over the coil gradually, more or less, and so reduces the strength of current in the welder itself, which is thus under complete control. The welding of pieces of copper, brass, and iron wire by this welder was shown making perfect joints. A little borax is sprinkled over the point of contact, but for copper or iron this is not really necessary. In a larger machine pieces of iron rod were likewise welded; the two halves of a chain link were simultaneously welded, the operation being under perfect control and in full sight of the operator.

One most interesting part of the applicability of the process is that not of welding, but of simply heating the bars for the purpose of bending or of otherwise working it afterwards. A piece of ¾ iron rod was slipped into the clamps and the current turned on. Immediately a slight smoke arises, the rod turns from black to red, and from red to white hot almost instantaneously. The current is cut off and the operator can take out the rod, and with his hands (for the outer ends have not had time to get even warm) bends the thick rod any way he pleases. This demonstration opens out unlimited possibilities for the manipulation of metals, in bending to shape, twisting, or forging. There is no fire with the ashes to obstruct the sight, no uncomfortable heat, no furnace, no blast. Simply two large clamps to adjust and a handle to turn and the bar rises to any temperature desired, and may be kept at one temperature for any desired length of time, or may be taken out and wrought to shape. The time required to heat the bar is often less than half a second.

Bars of iron an inch or so square were, with a larger machine, welded with almost equal facility as smaller rods, being placed in the machine, brought up to welding heat, forced together, and removed within one minute and a half. These examples, besides demonstrating its utility for general smithy work, also showed how the costly steel, Mushet's or other very hard steel, used for turning tools when worn down can be welded to a bar of iron, and so worn to the last half-inch, instead of, as now, being thrown away while still only half worn, and thus wasted as to half their length. Iron hydraulic tubes were welded in the same machine. The joints being planed down showed a perfect weld, homogeneous with the solid parts.

Steel boiler-plates have been rivetted with electricity in the same manner, and the specimens were also shown planed across, showing how the rivet, owing to the great heat, has been forced into every interstice and cranny of the two lapped plates, making a most thorough rivet joint. A point of importance is that several rivets can be done at one operation.

It is understood that a series of tests will be made with various trades—such as on carriage tires and axles, etc.—both as to the time required, and the effectiveness of the weld, by this process, for manufacturers themselves. We believe that therefore there is every possibility of electric welding being introduced into England on a scale commensurate with its importance in the industries.

We may mention as the first practical application of electric welding in England, that Mr. Webb, of the London and North-Western Railway Works at Crewe, has one of the Thomson electric welders at work for welding the tubes utilising his tools to the utmost in the manner above indi- for the locomotive boilers, and for welding pieces of common iron to the waste pieces of steel.

INSTITUTION OF ELECTRICAL ENGINEERS.

INAUGURAL ADDRESS BY J. HOPKINSON, M.A., D.Sc., F.R.S., PRESIDENT, ON "MAGNETISM."

As old as any part of electrical science is the knowledge that a needle or bar of steel which has been touched with a loadstone will point to the north. Long before the first experiments of Galvani and Volta, the general properties of steel magnets had been observed—how like poles repelled each other, and unlike attracted each other; how the parts of a broken magnet were each complete magnets with a pair of poles. The general character of the earth's magnetism has long been known—that the earth behaves with regard to magnets as though it had two magnetic poles respectively near the rotative poles, and that these poles have a slow secular motion. For many years the earth's magnetism has been the subject of careful study by the most powerful minds. Gauss organised a staff of voluntary observers, and applied his unsurpassed powers of mathematical analysis to obtaining from their results all that could be learned.

The magnetism of iron ships is of so much importance in navigation that a good deal of the time of men of great power has been devoted to its study. It was the scientific study of Archibald Smith; and Airy and Thomson have added not a little to our practical knowledge of the disturbance of the compass by the iron of the ship. Sir W. Thomson, in addition to much valuable practical work on the compass, and experimental work on magnetism, has given the most complete and elegant mathematical theory of the subject. Of late years the development of the dynamo machine has directed attention to the magnetisation of iron from a different point of view, and a very great deal has been done by many workers to ascertain the facts regarding the magnetic properties of iron. The upshot of these many years of study by practical men interested in the mariner's compass or in dynamo machines by theoretical men interested in looking into the nature of things, is, that although we know a great many facts about magnetism, and a great deal about the relation of these facts to each other, we are as ignorant as ever we were as to any reason why the earth is a magnet, as to why its magnetic poles are in slow motion in relation to its substance, or as to why iron, nickel, and cobalt are magnetic, and nothing else, so far as we know, is to any practical extent. In most branches of science the more facts we know the more fully we recognise a continuity in virtue of which we see the same property running through all the various forms of matter. It is not so in magnetism ; here the more we know the more remarkably exceptional does the property appear, the less chance does there seem to be of resolving it into anything else. It seems to me that I cannot better occupy the present occasion than by recalling your attention to, and inviting discussion of, some of those salient properties of magnetism as exhibited by iron, nickel, and cobalt—properties most of them very familiar, but properties which any theory of magnetism must reckon with and explain. We shall not touch on the great subject of the earth as a magnet—though much has been recently done, particularly by Rücker and Thorpe—but deal simply with magnetism as a property of these three bodies, and consider its natural history and how it varies with the varying condition of the material.

To fix our ideas, let us consider, then, a ring of uniform section of any convenient area and diameter. Let us suppose this ring to be wound with copper wire, the convolutions being insulated. Over the copper wire let us suppose that a second wire is wound, also insulated, the coils of each wire being arranged as are the coils of any ordinary modern transformer. Let us suppose that the ends of the inner coil, which we will call the secondary coil, are connected to a ballistic galvanometer, and that the ends of the outer coil, called the primary, are connected through a key for reversing the current with a battery If the current in the primary coil is reversed, the galvanometer needle is observed to receive a sudden or impulsive deflection, indicating that for a short time an E.M.F. has been acting on the secondary coil. If the resistance of the secondary circuit is varied, the sudden deflection of the galvanometer needle varies inversely as the resistance. With constant resistance of the secondary circuit the deflection varies as the number of convolutions in the secondary circuit. If the ring upon which the coils of copper wire are wound is made of wood or glass, or, indeed, of 99 out of every 100 substances which could be proposed, we should find that for a given current in the primary coil the deflection of the galvanometer in the secondary circuit is substantially the same. The ring may be of copper, of gold, of wood, or glass, it may be solid or it may be hollow, it makes no difference in the deflection of the galvanometer. We find, further, that with the vast majority of substances the deflection of the galvanometer in the secondary circuit is proportional to the current in the primary circuit. If, however, the ring be of soft iron, we find that the conditions are enormously different. In the first place, the deflections of the galvanometer are very many times as great as if the ring were made of glass, or copper, or wood. In the second place, the deflections on the galvanometer in the secondary circuit are not proportional to the current in the primary circuit; but as the current in the primary circuit is step by step increased we find that the galvanometer deflections increase somewhat as is illustrated in the accompanying curve (Fig. 1),* in which the abscissæ are proportional to the primary current, and the ordinates are proportional to the galvanometer deflections. You observe that as the primary current is increased the galvanometer deflection increases at first at a certain rate ; as the primary current attains a certain value the rate at which the deflection increases therewith is rapidly increased, as shown in the upward turn in the curve. This rate of increase is maintained for a time, but only for a time. When the primary current attains a certain value the curve bends downward, indicating that the deflections of the galvanometer are now increasing less rapidly as the primary current is increased ; if the primary current be still continually increased, the galvanometer deflections increase less and less rapidly.

Now, what I want to particularly impress upon you is the enormous difference which exists between soft iron on the one hand, and ordinary substances on the other. On this diagram I have taken the galvanometer deflections to the same scale for iron, and for such substances as glass or wood. You see that the deflections in the case of glass or wood, to the same scale, are so small as to be absolutely inappreciable, whilst the deflection for iron at one point of the curve is something like 2,000 times as great as for non-magnetic substances. This extraordinary property is possessed by only two other substances besides iron—cobalt and nickel. On the same figure are curves showing on the same scale what would be the deflections for cobalt and nickel, taken from Prof. Rowland's paper. You observe that they show the same general characteristics as iron, but in a rather less degree. Still, it is obvious that these substances may be broadly classed with iron in contradistinction to the great mass of other bodies. On the other hand, diamagnetic bodies belong distinctly to the other class. If the deflection with a non-magnetic ring be unity, that with iron, as already stated, may be as much as 2,000; that with bismuth, the most powerful diamagnetic known, is 0·999825—a quantity differing very little from unity. Note, then, the first fact which any theory of magnetism has to explain is : iron, nickel, and cobalt, all enormously magnetic ; other substances practically non-magnetic. A second fact is : with most bodies the action of the primary current on the secondary circuit is strictly proportional to the primary current ; with magnetic bodies it is by no means so.

You will observe that the ordinates in these curves, which are proportional to the kicks or elongations of the galvanometer, are called induction, and that the abscissæ are called magnetising force. Let us see a little more precisely what we mean by the terms and what are the units of measurement taken. The elongation of the galvanometer measures an impulsive E.M.F.—an F.M.F. acting for a very short time. Charge a condenser to a known potential, and discharge it through the galvanometer ; the needle of the galvanometer will swing aside through a number of divisions proportional to the quantity of electricity in the condenser—that is, to the capacity and the potential. From this we may calculate the quantity of electricity required to give a unit elongation. Multiply this by the actual resistance of the secondary circuit, and we have the impulsive E.M.F. in volts and seconds, which will, in the particular secondary circuit, give a unit elongation. We must multiply this by 10^8 to have it in absolute C.G.S. units. Now, the induction is the impulsive E.M.F. in absolute C.G.S. units divided by the number of secondary coils, and by the area of section of the ring in square centimetres. The line integral of magnetising force is the current in the primary in absolute C.G.S. units—that is, one-tenth of the current in amperes, multiplied by 4π. The magnetising force is the line integral divided by the length of the line over which that line integral is distributed. This is, in truth, not exactly the same for all points of the section of the ring—an imperfection so far as it goes in the ring method of experiment. The absolute electromagnetic C.G.S. units have been so chosen that if the ring be perfectly non-magnetic the induction is equal to the magnetising force. We may refer later to the permeability, as Sir W. Thomson calls it ; it is the ratio of the induction to the magnetising force causing it, and is usually denoted by μ.

There is a further difference between the limited class of magnetic bodies and the great class which are non-magnetic. To show this, we may suppose our experiment with the ring to be varied in one or other of two or three different ways. To fix our ideas, let us suppose that the secondary coil is collected in one part of the ring, which, provided that the number of turns in the secondary is maintained the same, will make no difference in the result in the galvanometer. Let us suppose, further, that the ring is divided so that its parts may be plucked from together, and the secondary coil entirely withdrawn from the ring. If now the primary current have a certain value, and if the ring be plucked apart and the secondary coil withdrawn, we shall find that, whatever be the substance of which the ring is composed, the galvanometer deflection is one-half of what it would have been if the primary current had been reversed. I should perhaps say approximately one-half, as it is not quite strictly the case in some samples of steel, although, broadly speaking, it is one-half. This is natural enough, for the exciting cause is reduced from—let us call it a positive value—to nothing when the secondary coil is withdrawn ; it is changed from a positive value to an equal and opposite negative value when the primary current is reversed. Now comes the third characteristic difference between the magnetic bodies and the non-magnetic. Suppose that, instead of plucking the ring apart when the current had a certain value, the current was raised to this value and then gradually diminished to nothing, and that then the ring was plucked apart and the secondary coil withdrawn. If the ring be non-magnetic, we find that there is no deflection of the galvanometer; but, on the other hand, if the ring be of iron, we find a very large deflection, amounting, it may be, to 80 or 90 per cent. of the deflection caused by the withdrawal of the coil when the current had its full value. Whatever be the property that the passing of the primary current has imparted to the iron, it is clear that the iron retains a large part of this property after the current has ceased. We may push the experiment a stage further. Suppose that the current in the primary is raised to a great value, and is then slowly diminished to a smaller value, and that the ring is opened and the secondary coil withdrawn. With most substances we find that the galvanometer deflection is precisely the same as if the cnrrent had been simply raised to its final value. It is not so with iron: the galvanometer deflection depends not alone upon the current at the moment of withdrawal, but on the current to which the ring has been previously subjected. We may then draw another curve (Fig. 2) representing the galvanometer deflections produced when the current has been raised to a high value and has been subsequently reduced to a value indicated by the abscissæ. This curve may be properly called a descending curve. In the case of ordinary bodies this curve is a straight line coincident with the straight line of the ascending curve, but for iron is a curve such as is represented in the drawing. You observe that this curve descends to nothing like zero when the current is reduced to zero; and that when the current is not only diminished to zero, but is reversed, the galvanometer deflection only becomes zero when the reversed current has a substantial value. This property possessed by magnetic bodies of retaining that which is impressed upon them by the primary current has been called by Prof. Ewing "hysteresis," or, as similar properties have been observed in quite other connections, "magnetic hysteresis." The name is a good one, and has been adopted. Broadly speaking, the induction as measured by the galvanometer deflection is independent of the time during which the successive currents have acted, and depends only upon their magnitude and order of succession. Some recent experiments of Prof. Ewing, however, seem to show a well-marked time effect. There are curious features in these experiments which require more elucidation.

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* We hope to give these figures in our concluding portion of this address.—Ed. *E. E.*

It has been pointed out by Warburg, and subsequently by Ewing, that the area of curve 2 is a measure of the quantity of energy expended in changing the magnetism of the mass of iron from that produced by the current in one direction to that produced by the current in the opposite direction and back again. The energy expended with varying amplitude of magnetising forces has been determined for iron, and also for large magnetising forces for a considerable variety of samples of steel. Different sorts of iron and steel differ from each other very greatly in this respect. For example, the energy lost in a complete cycle of reversals in a sample of Whitworth's mild steel was about 10,000 ergs per cubic centimetre; in oil-hardened hard steel it was near 100,000; and in tungsten steel it was near 200,000—a range of variation of 20 to 1. It is, of course, of the greatest possible importance to keep this quantity low in the case of armatures of dynamos, and in that of the cores of transformers. If the armature of a dynamo machine be made of good iron, the loss from hysteresis may easily be less than 1 per cent.; if, however, to take an extreme case, it were made of tungsten steel, it would readily amount to 20 per cent. In the case of transformers and alternate-current dynamo machines, where the number of reversals per second is great, the loss of power by hysteresis of the iron, and the consequent heating, become very important. The loss of power by hysteresis increases more rapidly than does the induction. Hence it is not well in such machines to work the iron to anything like the same intensity of induction as is desirable in ordinary continuous-current machines. The quantity, O A, when measured in proper units, as already explained, that is to say, the reversed magnetic force, which just suffices to reduce the induction as measured by the kick on the galvanometer to nothing after the material has been submitted to a very great magnetising force, is called the "coercive force," giving a definite meaning to a term which has long been used in a somewhat indefinite sense. The quantity is really the important one in judging the magnetism of short permanent magnets. The residual magnetism, O B, is then practically of no interest at all; the magnetic moment depends almost entirely upon the coercive force. The range of magnitude is somewhat geeater than in the case of the energy dissipated in a complete reversal. For very soft iron the coercive force is 1·6 C.G.S. units; for tungsten steel, the most suitable material for magnets, it is 51 in the same units. A very good guess may be made of the amount of coercive force in a sample of iron or steel by the form of the ascending curve, determined as I described at first. This is readily seen by inspection of Fig. 3, which shows the curves in the cases of wrought iron, and steel containing 0·9 per cent. of carbon. With the wrought iron a rapid ascent of the ascending curve is made, when the magnetising force is small and the coercive force is small; in the case of the hard steel the ascent of the curve is made with a larger magnetising current, and the coercive force is large. There is one curious feature shown in the curve for hard steel which may, so far as I know, be observed in all magnetisable substances: the ascending curve twice cuts the descending curve, as at M and N. This peculiarity was, so far as I know, first observed by Prof. G. Wiedemann.

I have already called emphatic attention to the fact that magnetic substances are enormously magnetic, and that non-magnetic substances are hardly at all magnetic; there is between the two classes no intermediate class. The magnetic property of iron is exceedingly easily destroyed. If iron be alloyed with 12 per cent. of manganese, the kick on the galvanometer which the material will give, if made into a ring, is only about 25 per cent. greater than is the case with the most completely non-magnetic material, instead of being some hundreds of times as great, as would be the case with iron. Further, with this manganese steel, the kick on the galvanometer is strictly proportional to the magnetising current in the primary, and the material shows no sign of hysteresis. In short, all its properties would be fully accounted for if we supposed that manganese steel consisted of a perfectly non-magnetic material, with a small percentage of metallic iron mechanically admixed therewith. Thus the property of non-magnetisability of manganese steel is an excellent proof of the fact—which is also shown by the non-magnetic properties of most compounds of iron—that the property appertains to the molecule, and not to the atom; or, to put it in another way, suppose that we were to imagine maganese steel broken up into small particles, as these particles became smaller there would at length arrive a point at which the iron and the manganese would be entirely separated from each other; when this point is reached the particles of iron are non-magnetic. By the magnetic molecule of the substance we mean the smallest part which has all the magnetic properties of the mass. The magnetic molecule must be big enough to contain its proportion of manganese. In iron, then, we must have a collection of particles of such magnitude that it would be possible for the manganese to enter into each of them, to constitute an element of the magnet. Manganese is, so far as I know, a non-magnetic element. Smaller proportions of manganese reduce the magnetic property in a somewhat less degree, the reduction being greater as the quantity of manganese is greater. It appeared very possible that the non-magnetic property of manganese steel was due to the coercive force being very great—that, in fact, in all experiments we were still on that part of the magnetisation curve below the rapid rise, and that if the steel were submitted to greater forces it would presently prove to be magnetic, like other kinds of steel. Prof. Ewing, however, has submitted manganese steel to very great forces indeed, and finds that its magnetism is always proportional to the magnetising force.

(To be continued.)

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PROSPECTIVE AND RETROSPECTIVE.

Since referring to the question of deterioration of conductors in our last issue, it has occurred that there may be a phase of the subject needing the most careful attention. Then, again, the question of danger has been discussed in an interview between the *Pall Mall Gazette* and Mr. Heaphy. It is not too much to say that Mr. Heaphy, representing, as he does and has done, the great fire insurance companies through the whole era of electric lighting, has accumulated an experience that is unique, and could it be published, would be of enormous value in showing what not to do and how not to do it. The experience is one of disaster, of failure, and every failure should teach its lesson. Now Mr. Heaphy has been brought into contact with every firm of repute engaged in the electric lighting industry, he has never withheld suggestions or refused the results obtained from his experience, and many improvements have been made in auxiliary apparatus through these suggestions, by which others rather than himself benefit. We have not failed to interview Mr. Heaphy as occasion required, and must confess that, while willing to give every credit and mention every name connected with good work, he is extremely reticent about giving information other than general, where such information would not redound to the credit of the contractors. It is requisite that the insurance companies should have an engineer who can neither be bullied nor cajoled, and for all these reasons, to which many others might be added, we trust that sooner or later Mr. Heaphy may be induced to publish a list of failures. It would not be necessary to mention names, for we all have to learn, and in doing so learn that what was satisfactory five years ago would not be tolerated now. We would suggest that those who think with us in this matter might take an opportunity of supporting the idea. Whether the members of the industry think so or not, it is an undoubted fact that to Mr. Heaphy, and almost to him alone, is due our thanks for having preserved us from the happy-go-lucky way in which our American cousins put up installations. He stands between the profession and those who have to pay the piper in case of fire, and from the earliest time to the present he seems to have added rules to rules which, if followed, would avoid the dangers his experience has made him acquainted with. We understand that accidents have occurred at various times from every part of an installation, here it has been a joint, there a lamp, at this place a switch, at another a careless fixing of good wire, then sparks from the dynamo, and so on. Mention of the bad fixing of good wire reminds us that some people cannot discriminate between good wire and bad fixing. In the most recent case a critic damned the insulated wire, and would have had some other kind, even when a staple was driven right through the insulation. We should like to know what possible insulation will stand against such rough usage.

To come back to the question of deterioration. In any installation there must necessarily be a greater or less number of what may be termed vulnerable points; that is, points in the conductor or contact pieces that are attackable by gases and acids or other deleterious materials. The conductor as a conductor when tested may show no signs of deterioration, and yet day by day the installation gets worse. The size of wire is calculated according to, say, the Board of Trade rule, and a margin is allowed. The men in charge are worried after a time by breakdowns which are traced to vulnerable points. The moral of the tale is to pay particular attention to see that, in the first place, the materials and work at these vulnerable points is the best possible, and to allow a larger margin of safety at these points than ordinarily.

In a general review of the year's work, another question strikes us as of some importance, the training of the men who are to enter the industry. We have the schools in Hanover-square, of exceedingly high repute. We have the places under the control of the City guilds. We have classes in many of the local colleges, but we wish to insist upon some practical work in addition before a man is accounted a competent electrical engineer. If the men who attend these classes would look upon them as a part only—a very valuable part, we admit—of their training, they would find it would be greatly to their advantage. At the present time a number of men are turned out, some of whom are silly enough to give themselves airs and to talk and act as if a brand new diploma were as valuable as twenty years' experience in the shops. It will be well to remind those of our readers who have sons desirous of entering this industry, that the men who are wanted are men who do not mind stoking a fire, oiling bearings, making splices, using spanners, and generally doing any work that comes within the duties of a mechanical engineer. The numbers required to design machines is limited, as are those required to make calculations for and design central station work. This no doubt is more highly paid, and more cleanly, but even then the men who produce the best designs are the men who have had practical experience. The opening for men who may be termed the artisans of the industry is now large, and will grow month by month. These are the men whose work will have to be rigidly examined, but while the men are many, the examiners are few. We would suggest to those who rule in the schools and colleges that a part of the curriculum should include the work of designing, of writing specifications, and of examining work done. One student might specify, others work to the specification, and another examine and report thereon. This would, in the first place, lead to a more exact knowledge of what was required, and, in the second place, would bring out prominently the faults sure to remain from book knowledge only, besides emphasising the wide divergence that there is, and always must be, between practice and theory. The book tells a man that such and such a formula holds good, and so it does, but very often not in practice. Many a man has set out with a wonderful knowledge about insulation, and been thunderstruck to find in practice the insulation resistance of an installation is far below what he would expect it to be. He knows what the insulation resistance of a yard or a mile of such covered wire is, but while knowing this he forgets that he will be troubled with such little things as lamps, with joints, with switches, with cut-outs, and all the paraphernalia besides the wire, and expects his resistance to be that of so many yards or miles of wire. This, then, means a drain from leakage that the inexperienced make no provision for. Yet they will find leakage a bugbear both to the electric light man and to the gas man. Leakage also spells danger, so we think our suggestion not out of place—in the schools less theory, and more directly applying what little theory is needed to practice.

Bourne and Son.—Messrs. Bourne and Son, of Derby, have been fully employed during the year in the department of their manufactory set apart for the production of stoneware electrical productions. The leading shapes and sizes of insulators for telegraphic, electric light, and mining signals, which have been produced in such large quantities by this firm, have been in continual demand, and there has been much activity in the battery cell branches. The most noticeable feature of the trade during the year just past has been the large number of fluid-oil insulators made by the firm for the patentees, Messrs. Johnson and Phillips, whilst the increased activity in the coal trade has stimulated the demand for the insulators and battery cells used in mining operations. As regards the prospects for the year 1890, in addition to an anticipation of a continued demand of what may now be considered the staple articles of the trade, the firm has reason to expect larger orders than usual from the Postal-Telegraph Department.

Callender and Co.—This company has carried out several large contracts for laying mains, etc., undertaking the excavation and all the operations consequent thereon, the construction of the protecting conduit or case for the cables, and the manufacture and laying complete of the cables themselves, with all service and other boxes, to form a complete distributing network. The most important of these contracts are: (1) Liverpool, where they have laid a complete network throughout nearly the whole of the business quarter of the city, from which many thousands of lights are already being supplied. This work is for the Liverpool Electric Supply Company, Limited, and is by far the most complete and extensive system in operation in England. (2) Whitehall, for the Metropolitan Electric Supply Company, Limited, comprising mains from the Thames Embankment to Charing Cross-road and Pall Mall. (3) Strand, for Messrs. A. and S. Gatti, complete system of distribution in the Strand and neighbouring streets from the station in Bull Inn-yard. (4) Chelsea, for the Chelsea Electricity Supply Company, Limited, complete system in Sloane-square, Cadogan-square, Hans-place, Lennox-gardens, Pont-street, Sloane-street, and the adjoining streets from the stations in Draycott-place and Clabon-mews. (5) South Kensington, for the Chelsea Electricity Supply, for similar work in Egerton-gardens, Brompton-road, Ovington-square, etc., from the station in Egerton-mews. (6) Bath, underground mains for arc lighting for the public lamps throughout the city, and for house lighting by transformers. This company have also supplied the cables for central station work at Lynmouth and Lynton, Gothenburg, Sweden, (two companies), La Plata, Ensenada, Rosario, and Buenos Ayres (for the River Plate Electricity Supply Company, Limited). Among the very large number of orders for cables for use by the various firms of electrical engineers, quite a feature has been the quantity of colliery installations for which this company has manufactured mains. A large number of private houses have also been fitted in all parts of England and Scotland. They have also been very busy supplying cables for the Navy, of the well-known yarn, bitumen, and lead sheathed type. The company has held the contract with the Admiralty for the past two years, and have supplied through contractors the wires and cables for many ironclads building on the Tyne and Clyde. The past year has been a very busy one, and there is every indication, from the large numbers of orders already placed, that 1890 will be still busier.

Chamberlain and Hookham.—Besides the manufacture of a large number of dynamos, this firm has carried out an important installation at the quick firing range and loading sheds and ammunition works of the Birmingham Small Arms and Metal Company, Limited, and also the underground and surface at the Hamstead Colliery Company, Limited. Among other things, they have taken out a patent for and perfected the working of an arrangement of intermediate magnets for securing constant lead, speed, and potential in dynamos and motors. They have further improved Hookham's patent electricity meter for continuous currents, and have trebled the sales. They are now in sole use in Liverpool, Leamington, and Derby, and with others in Bradford and London. They have also been perfecting the same for alternating currents, and hope to put these on the market shortly.

John Davis and Son.—Messrs. John Davis and Son have been very busy during the past year; their work executed and in prospect includes installations with accumulators at country houses, mills, foundries, collieries, etc. In the early part of the past year they started in Derby a central supply station with accumulators, which has been working with perfect success ever since. The plant has at present a total capacity of about 500 10-c.p. lamps. The consumers are charged by meter on a sliding scale of 1s. to 8d. per Board of Trade unit. The mains are carried overhead attached by insulating fasteners to copper bearers. Amongst recent installations are Messrs. Geo. Fletcher and Co.'s, Masson Works, Derby; the Cossall Colliery, Ilkeston; two pits for the Clay Cross Company (in which the plant is arranged for pumping as well as lighting), and a colliery for Messrs. Barber, Walker, and Co., all of these being lit above and below ground; also an extensive plant for the Cerro de Pasco goldfields, Transvaal. Messrs. Davis report that though all branches are active, that transmission of power plant for underground hauling and pumping is constantly enquired after, and they have several large plants in prospect. In their experience in colliery lighting, Messrs. Davis have found it necessary in almost every case to protect the lamps against accidental breakage, dust, and dirt; they therefore commenced the manufacture of protector fittings for incandescent lamps of all sizes, all of which are dust-proof. These are now extensively adopted by many firms.

General Electric Company.—This company have during the past year increased both their manufacturing premises, as well as their warehouses and offices. The factory in Manchester has been equipped, at great expense, with a quantity of new machinery, and now gives employment to over 300 men. The machinery, which is throughout of the latest type, comprises automatic screw-making plant, many new apparatus for brass finishing, clockmakers, cabinet-makers, and wood-turners' tools, and a large plant for nickel and electro plating. Many new articles have been added to their list of manufactures, such as ammeters and voltmeters, arc lamps, and telegraph materials, whilst the output in switches, cut-outs, ceiling roses, and general fittings has largely increased. The firm have had the advantage of Mr. Reckenzaun's advice and general assistance, and with him have brought out a number of apparatus, with the production of which their experimental department is now fully occupied. Clark's patent electric gas lighter continues to be manufactured with unabated energy, and it is astonishing what a sale there is for it, considering that it has, for a considerable time, only sold through its commending qualities. Altogether, as a centre for the sale of articles, the Manchester works have proved a great success. In London the large building in Queen Victoria-street is well known through its prominent position, and the business has been greatly facilitated by the commodious premises, although the company complain that their expectations as to this winter's business have not been realised, and attribute this disappointment to the fact that their customers, who comprise almost every contractor for electric lighting, cannot fulfil the calls made upon them, owing to the backward state of affairs in central stations in London and the provinces. Besides the increased sale of their standard articles, the demand for their specialities, such as Dr. Aron's electricity meters, Apostle carbons, and well-assorted designs in glassware, has been very great. Orders from all parts of the globe, especially from Australia and South America, keep coming in, and business in general looks very promising.

Manchester Edison-Swan Company.—The Manchester Edison-Swan Company have been fully employed during 1889. In the early part of the year they completed a central station on the low-tension system at St. John's, Newfoundland, the Houses of Assembly, the Government House, and other buildings being lighted. Installations, many of large size, have been erected in the mills and works of undermentioned firms: Messrs. Larios Bros., Malaga and Gibraltar; the Union Mill Company, Rochdale; Ffaring, Eckersley, Wigan; Sladen Wood Mill Company, Littleboro'; Ainsworth Bros., Bolton; Textile Mill Company, Oldham; J. Mandleberg and Co., Pendleton; Wilde and Booth, Denton; J. and J. Mellor, Bury; Staul, Guyer, and Spitz, Cannington, Shaw, and Co., Yates and Kay, and many others. The whole of the extensive premises of the Bolton Cooper Syndicate have been entrusted to the company, and the installation at the pavilion at Castle Mona, Douglas, and Llandudno, with the pier at the latter place, have also been carried out by them. Among private houses and hotels, those of Albert Wood, Esq., Conway; John Walker, Esq., Llandudno; the St. George's Hotel, Llandudno; the Osborne Hotel, Bradford; Palace Hotel, Birkdale; and the fine "Manchester, Limited," Restaurant, may be mentioned. The company has also carried out numerous wiring installations for central station work in shops and offices. At the present time they have in progress installations for Messrs. Calvert and Co., the Kellner Partington Wood Pulp Company, Combatore Mill Company, Langdale and Co., Fletcher, Burrows, and Co., Atherton, and others. Some idea of the progress of electric lighting in the district may be gathered from the fact that during the past year this company has supplied something like 40,000 incandescent lamps, and the present outlook is a very satisfactory one.

R. L. B. Rathbone.—The work of this firm during the past year has consisted chiefly in the designing and manufacture of more or less artistic fittings, in polished brass and copper, for house and office electric lighting, into some of which have been introduced a remarkably powerful American reflector shade, which was illustrated in our columns. These are said to be highly appreciated in offices where the absence of any glare, and the intense whiteness and power of the light, have afforded a very welcome relief. In the course of 1890 larger and more convenient workshops are to be fitted to develop several specialities in electric light fittings for billiard lighting, picture lighting, and ship work, besides other fittings for domestic and office work.

School of Electrical Engineering.—The school has had more students during the latter half of 1889 than in any similar period in its history, and the enquiries with a view to entry are still very numerous. Frequent evidence reaches the managers of the rising esteem in which the school is held by members of the profession. There is but little difficulty in finding good berths for able young men who get the certificate, at the final examinations for which, both in theory and practice, the examiner is Mr. Gisbert Kapp. A new gas-engine is just being erected, and a transformer current is to be installed, and the management is generally doing what seems best suited to maintain the plant in a high state of efficiency, and to keep it abreast of the times.

Telegraph Manufacturing Company.—We hear from this company that last year has been an extremely busy one, especially the last six months, during which the output has been doubled. All departments have been fully occupied, especially the cable and guttapercha wire covering departments, and the firm has large orders for all classes of goods in hand for this year.

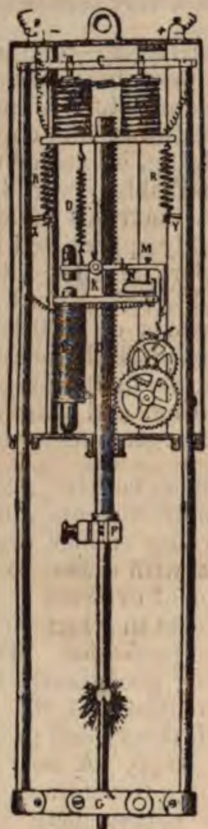
Western Counties and South Wales Telephone Company.—The district worked by this company covers Cornwall, Devonshire, Somersetshire, Dorsetshire, the Channel Islands, Hampshire, the Isle of Wight, Wiltshire, Gloucestershire, Herefordshire, Monmouthshire, Glamorganshire, Carmarthenshire, Pembrokeshire, Cardiganshire, Brecknockshire, and Radnorshire, and all such parts of Shropshire, Warwickshire, and Worcestershire as are not included in a twenty mile radius from the general post offices at Birmingham and Wolverhampton respectively. The company have 39 exchanges, distributed as follows: Bristol, Clifton, Bath, Gloucester, Cheltenham, Newport, Pontypool, Cardiff, Penarth, Barry, Barry Docks, Cadoxton, Pontypridd, Aberdare, Merthyr, Tredegar, Swansea, Morriston, Neath, Briton Ferry, Llanelly, Plymouth, Devonport, Mutley, Exeter, Torquay, Paignton, Newton Abbot, Brixham, Dartmouth, Portsmouth, Bournemouth, Poole, Southampton, Winchester, Shrewsbury, Worcester, Weymouth, St. Heliers (Jersey), with a total number of exchange subscribers and trunk renters of 2,377 (as on Dec. 21st, 1889). The principal exchanges are Bristol with 451 subscribers, Plymouth 278, Bournemouth 230, Portsmouth 196, Torquay 126, and Southampton 107. The calls at the company's exchanges for the month of November, 1889, were 210,836, but as each call requires and receives a reply this number should be doubled to give the number of communications for the month of November, 421,672. The number of such communications for the year 1888 were nearly four millions, the exact figures being 3,909,856. For the eleven months of the present year—*i.e.*, up to 30th November last—the number of communications which have passed through the company's exchanges have exceeded four and a half millions, the figure being 4,523,260; estimating for December 387,000; giving a total of 4,910,260, or just a million increase for the year 1889. The company on the 14th December, 1889, had 669 private lines, and these were distributed over 130 places in the company's territory, thus in many cases bringing the telephone into the most remote towns and villages, and for the greatest variety of purposes, from the farm and rural requirements of one part of the country to the mines and collieries of another. In the Bristol, Bath, Gloucester, and South Wales district, the whole of the following towns are connected together with each other: Bristol, Bath, Portishead Docks, Avonmouth, Sharpness, Gloucester, Cheltenham, Newport, Pontypool, Cardiff, Pontypridd, Aberdare, Merthyr, Tredegar, Swansea, Neath, Morriston, Briton Ferry, Llanelly, the most distant points being Bath to Llanelly, 142½ miles. In Devonshire all the following places are connected by trunk lines: Plymouth, Devonport, Mutley, Plympton, Ivybridge, Totnes, Paignton, Torquay, Newton Abbot, Brixham, Dartmouth, the most distant points being Plymouth to Dartmouth, 36 miles. In the South of England, Bournemouth is connected with Poole, and Portsmouth with Southampton and Winchester, and the trunks between Portsmouth and Bournemouth are almost completed. The most distant point will then be Poole to Portsmouth, 58 miles. The company have 373 miles of trunk route completed, and 1,478 wire miles of trunks. The calls on the company's trunk lines for the month of November, 1889, were 18,157, or 36,314 communications. On January, 1889, a span of wire, 800 yards in length, was erected over the River Dart at a height of 288ft. above high-water mark. Silicium bronze wire, No. 17, was used, weighing 24lb. for the span. This span is believed to be the longest in England. The working has been perfect, notwithstanding the two heavy gales which have occurred since its erection.

Willans and Robinson.—The work of the year, though of course greatly hampered by the destruction of the company's machine shops by fire, in November, 1888, and by the limited producing power of the temporary shops which replaced them until the new ones were brought into working order last summer, has nevertheless much exceeded that of any previous year. Electric light work, by its importance and urgency, has claimed the greater part of the company's attention, and the fact that the electric light engines made by this one firm (or put in hand for completion within a few weeks from now) are capable of indicating about 18,000 h.p., shows, not only how great a reputation the Willans engine, and its system of direct driving, have obtained, but what a large amount of lighting work is now in progress in the country. Out of the 18,000 h.p. about 4,000 is for ship lighting, but the balance is nearly all for land installations in England; certainly not 1,000 h.p. is for abroad. Central stations, of course, account for the greater part of the work: thus the Metropolitan Electric Supply Co. (through the Electric Construction Corporation) are responsible for 3,500 i.h.p. for their stations in Rathbone-place and Manchester-square alone; the St. James's and Pall Mall Company, whose installation was entrusted to Messrs. Latimer Clark, Muirhead, and Co., for about 2,200 i.h.p.; Messrs. Crompton and Co. (for the Kensington and Knightsbridge Company), over 1,200 i.h.p.; the Liverpool Electricity Supply Company, about 1,500 i.h.p.; Messrs. Siemens, for the Bradford Corporation station, under the supervision of Mr. Shoolbred, 300 i.h.p., (capable of larger output when required); the Brush Electrical Engineering Company (for the Chelsea Electric Supply Company) nearly 500 i.h.p.; the Taunton Electric Light Company, 300 i.h.p., and others. Amongst other large installations may be named two, through Messrs. B. Verity and Sons, for Mr. D'Oyly Carte—viz., engines of about 650 i.h.p., for the Savoy mansions and hotel, theatre, etc.; and, a later order, about 400 i.h.p. for Mr. Carte's new theatre in Shaftesbury-avenue. The General Post Office has ordered two complete installations, including the dynamos (but not other electrical work), amounting to 400 i.h.p. collectively; and the Gulcher Company has ordered two engines of 60 i.h.p. each for the Post Office at Rio de Janeiro. Amongst other large customers in the year may be mentioned the English Admiralty, for whom at least sixty engines, mostly of large size, have been put in hand; Messrs. Sharp and Kent (about 500 i.h.p.); Messrs. Mather and Platt (300 i.h.p.); a large hotel in Sydney (160 i.h.p.); Great Western Railway Co., for three new Channel steamers (75 i.h.p.); the Hotel Metropole at Monte Carlo (120 i.h.p.); and, later, the Hotel Metropole at Brighton (240 i.h.p.); the Grand Hotel, Charing Cross; an hotel at Gothenburg; Elmore's Copper Depositing Company (160 i.h.p.); Elliott's Metal Company (250 i.h.p.); and a number of private users for mills and mansions, etc. It is a satisfactory feature that many of the orders are "repeat" orders, and that the prospects of work for the coming year are very good indeed, chiefly, of course, so far as at present known, for central stations both in London and elsewhere.

THE GRAMME ARC LAMP.

The arc lamp illustrated herewith has been introduced by the Société Gramme, and was employed by them in their installations at the Paris Exhibition. As will be seen, it forms a simple type of gravity escapement lamp. It contains two electromagnets, the first, AA, making part of the main circuit, and second, B, being in shunt. While the lamp is not working the carbons remain in contact. The current coming in at the positive terminal, passes along the carbons and the electromagnet A A, which attracts the cross piece, C, forming the armature; the long rods, E E, fixed to the cross piece, C, are actuated by the movement; in descending they press down the piece, G, which constitutes the lower carbon-holder, and the movement of the lower carbon strikes the arc. While the lamp is burning the cross piece, C. remains attracted and keeps the piece G in position against the pull of the springs RR, which tend to lift it up.

The upper carbon-holder, D, is regulated by the second electromagnet, B. This latter, wound with fine wire, offers a relatively high resistance, and only a very slight current passes when the arc is normal, dividing at the point P; but when the arc grows longer, offering a higher resistance, a larger current passes around the electromagnet B, which then becomes sufficiently strong to attract the armature I, usually kept up by a coiled spring, U. This armature is mounted upon the lever, L, moving upon the pivot V; when it is drawn down it therefore raises the further extremity of the lever, L, which is bent over and prolonged by a finger, S. This finger forms a stop, preventing the movement of the last of a train of wheels which at the other end engage in the rackwork, D, which forms the body of the upper carbon-holder and is sufficiently heavy to descend with its own weight. The raising of the stopfinger, S, allows the wheels to revolve: and the rackwork, D, descends and the carbons come together.



The Gramme Arc Lamp.

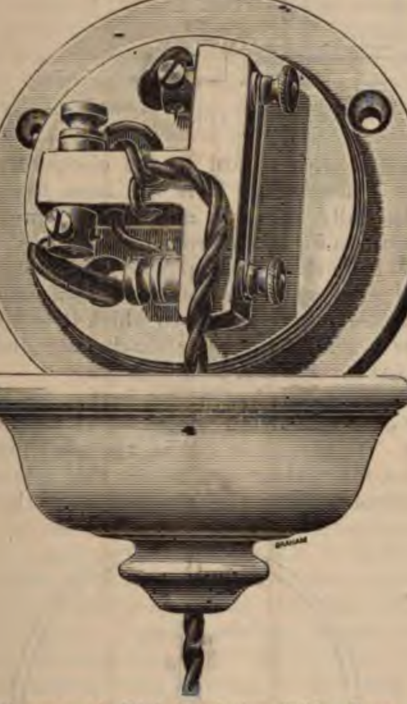
Before the carbons touch there is a decrease of resistance in the arc, a larger quantity of current passes in main circuit and a lesser quantity in the shunt circuit of the lamp: the attractive force of the electromagnet B becomes less, the armature, I, is raised, and the finger, S, is lowered, stopping the train of wheels: carbon-holder D therefore ceases to fall, until by the burning of the carbons and the lengthening of the arc the same movements are repeated.

The method of regulation is very characteristic. Every time the armature of B, having been drawn down, has allowed the train of wheels to revolve, the shunt circuit, which is closed by the regulating screw, M, touching against the spring N, is broken at N; the magnetic effect then ceases completely and the armature is drawn up by the action of the spring U; the train of wheels is again stopped and the descent of the carbon-holder is arrested. But very shortly the circuit becomes again completed, and when the current passing through B is strong enough the lever is again attracted and so on while the lamp is burning. The result is a species of vibration which feeds the carbons by a series of movements so slight as to be unnoticeable, and the light given by the lamp has a steadiness that leaves nothing to be desired.

BINSWANGER'S PATENT HIGH-INSULATION CEILING ROSE.

The use of ceiling roses has become very general for electric light installations of every kind. Both in the factory and in the drawing-room they are employed as the most convenient, safe, and artistic attachment of pendants to the mains. Since they were first introduced, like all other electrical fittings, they have had to undergo a great many changes, and to-day we expect a good ceiling rose to possess the following advantages: It should be fireproof, easily wired, strong enough for carrying weight, for which purposes no contact pieces should be used, should have plenty of room for a cut-out, and the whole construction should be so that dampness of the wall should not affect its insulating properties.

The illustration shows the latest type designed by Mr. G. Binswanger, and manufactured by the General Electric Company, Limited, which in a very efficient way combines all these requirements. On the top of the china base are walls, projecting in the shape of a T, to which the terminals are fixed in such a way that no brass parts of any kind are visible at the back of the ceiling rose. Two holes leading through these walls are for the purpose of separating the flexible wire, in the manner shown above, thus making it possible to connect considerable weight to the ceiling rose without strain on any of the contact pieces, while the wire is also separated at the base, so as to meet Mr. Heaphy's requirements. The terminals are very substantial, and there is 1ft. 4in. space for the cut-out, which is constructed for the use of tin or lead wires, with or without eyelets.



Binswanger's High-Insulation Ceiling Rose.

The rapid increase in the number of electric lighting central stations causes a proportionate increase in the demand for small fittings. More and more the success of an electric lighting installation will be dependent on these, and we are glad to notice that greater attention is being bestowed on them. We only hope that, like in America and on the Continent, manufacturers will combine to bring out a set of standard fittings, instead of each house producing its own types, a fact which has been detrimental to English competition in foreign markets.

Electric Ponies.—There are now being constructed at Paris by the Société de l'Eclairage Electrique, says the *Bulletin Internationale*, some artificial ponies of the natural size which will be put in motion by means of electric motors.

TRANSFORMERS.*

BY HARRIS J. RYAN.

The apparatus by means of which electrical energy of one form may be transformed to that of any other form, few engineers fail to appreciate.

So great have been the anticipated possibilities offered by the application of the modern transformer of alternate current energy that in most cases in our country especially has the transformer found immediate application, with but little thought or study of its exact performance. Much experimental work has been done by trial methods to the end that our manufacturers are able to supply transformers that answer for such that is desired practically with a commercial efficiency that can be made higher than is probably possible by any other transformer of energy.

In electrical engineering, as well as other branches of engineering for the broad application of one method or another, it is always of the highest importance that the cause and extent of every effect is thoroughly understood with regard to the mutual action and interaction of all forces and materials in relation to themselves, or to energy of one form or another.

It was with a view of obtaining as far as possible a clear understanding of all phenomena that take place in the commercial transformer, that the work producing the results here set forth was undertaken. It has not been possible at this time to prepare a paper as complete as has been desired, and we trust that in the near future we may add more data to that which is here presented.

In the outstart of this paper it should be said that the results of the experiments that are here presented were wrought out jointly by Ernest Merritt, of the Department of Physics, Cornell University, and the writer. What we had in mind in the work was an accurate determination of the exact performance of the commercial transformer, whereby one should be able to derive results and data that should enable all phases of the performance of the transformers to be understood clearly, and that should show the requisite principle of proper design. It may be well to state briefly the general method we employed. A single 10-light transformer that had been made and supplied for commercial purposes for incandescent lighting, with 1,000 volts in the primary and 50 volts in the secondary, was selected as a sample for investigation. It probably represented fairly well the average commercial performance of transformers, and might therefore be said to embody, to a certain extent, at least, proportions that have proven by experience and experiment to be best for theparticular purpose for which it is supplied.

This transformer was operated under the same impressed E.M.F. supplied from the electric lighting plant in which it had been used for supplying incandescent lamps commercially. It was operated with its secondary open and the same closed through one lamp, five lamps, and 10 lamps, and under the several conditions the exact instantaneous values of the ever-varying primary impressed E.M.F., primary current, and the E.M.F. at the terminals of the secondary were observed. Again, under these several conditions, the square roots of the mean squares of the above values and of the secondary current were also observed. Then, with these observations, the dimensions and the details of the construction of the transformer many of the facts and performances that the engineer is concerned with are brought to light.

Naturally the first things to be considered are the electrical measurements, and how they were made. A point on the armature of an alternator always passes a fixed point in its circumference at a time corresponding to a definite value of the varying E.M.F. and current alike, with regard to these quantities in the primary feeders, transformer, primary or secondary, etc., so long as the conditions remain constant. In our experiments we were only concerned with the values of the E.M.F. impressed at the terminals of the primary, the primary current and the secondary E.M.F., then, by changing the position of the fixed point relative to the machine, the rotating point of reference in the armature would pass the new position of the fixed point at corresponding different values for the primary E.M.F., primary current, and secondary E.M.F., with respect to themselves and the position of the armature.

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* Paper read before the American Institute of Electrical Engineers, New York, December 17, 1889.

In Fig. 1, B L is a prism of hard rubber bearing a projecting strip of brass, B, that on its upper side is filed to a dull edge. This edge is taken as a fixed point on the armature. An arm, F D, is arranged to rotate about D as a centre, a point that is in line with the axis of rotation of the armature. A semi-circular board of hard wood, attached rigidly to the dynamo frame, serves both as a support for this arm and a circumferential scale whereby the position of the arm may be shown relatively to the machine. The arm was made of brass and given the form shown in the figure. It was bent into a U shape at the top, so as to pinch the board, and thus remain fixed in any position desired. At the top of this arm is mounted a bar of hard rubber projecting toward the dynamo parallel to the armature axis. On its under side, fastened at G, is a brass strip, a tongue, H A, of spring brass is attached at the end and at right angles to the brass strip, H G, as shown. The position of this part of the apparatus is carefully adjusted so that the point about which the arm rotates is in line with the axis of rotation of the armature and the sharply upward curved end of the tongue, H A, just over the edge of the brass strip at B. Then when the armature is rotated the strip, H G, may be sprung inward radially by turning the thumb-screw, N, until the tip of the tongue A, is heard to just lightly touch the edge at B as it passes.

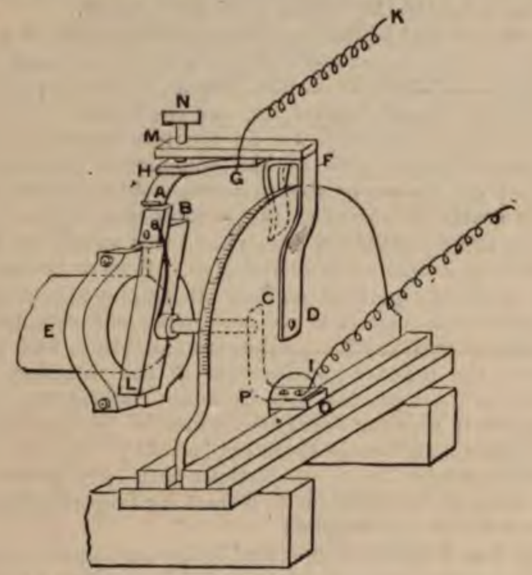

FIG. 1.

The arm may then be adjusted by hand so that the tongue will touch the fixed edge on the armature at any desired phase of the primary E.M.F., primary current, or secondary E.M.F. and current. Co-axial with the armature a small brass rod is mounted on the bar of hard rubber, B L. It is connected metallically to B by means of a wire. At O on the framework supporting the semi-circular board, etc., is mounted another piece of hard rubber, insulating and supporting the thin metallic strip, P C, that bears against the above brass rod. G and I then are the terminals of this commutating apparatus.

In Fig. 2 E F is a non-inductive resistance in series with the primary of the transformer which is at work. At A is the apparatus described in Fig. 1, and E is an electrometer reading through a wide range.

The terminals of the non inductive resistance and those of the electrometer are connected together through the commutating apparatus at A. Then it must be evident to all that the electrometer will become charged with a difference of potential equal to that existing between the terminals of the non-inductive resistance at the instant that the fixed edge on the armature passes the tip of the tongue in the apparatus at A. By reading the indications of the electrometer, therefore, and knowing the value of the non-inductive resistance, E F, the value of the primary current corresponding to the particular phase due to the position of the arm in the apparatus at A becomes known. In a similar manner the primary and secondary E.M.F. are observed by changing the connections accordingly at G^1,G^2,G^3,G^4. Then the arm is rotated to another position, corresponding to a different phase, and the corresponding values of E.M.F.'s. and current again observed as before. In this manner we proceed at equal intervals, sufficiently near, so that a curve may be determined by the values thus observed at the several intervals such that the values of the E.M.F.'s. or currents shall be accurately known at all times throughout a complete period.

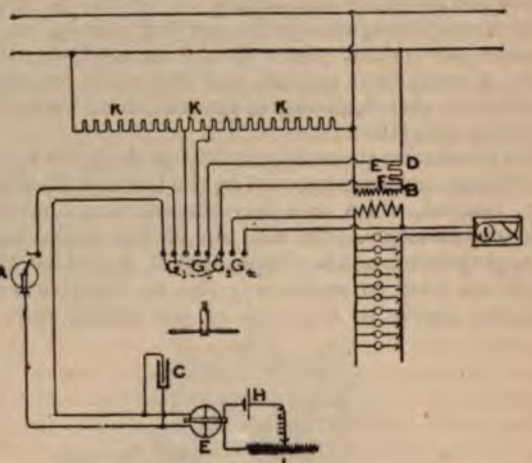

FIG. 2.

A few words with regard to the electrometer at E are not out of place here. It is the form that the writer devised especially for this and similar purposes. The essential features for an electrometer for these purposes are that it shall have the widest possible range through which it will read with accuracy. Its indications must be unvaried by the absolute potential to which it is subjected as a whole. Its law must be perfectly definite, and it is also desirable that its constant be unchanging.

Fig. 3 illustrates this instrument in diagram. It consists essentially of a cylindrical electrometer needle and quadrants, E D. To the upper side of the electrometer needle is attached a magnetised steel mirror that acts as a magnet and as a mirror for observing the position of the same. The needle is hung by a single silk fibre, H, from a hook in the top of the case as shown. Metallic contact from the needle to the case is made by means of a platinum wire ·0002in. in diameter. This wire is readily provided in the desired form by using the platinum cored silver wire that is supplied by makers of surveying apparatus. It is cut the desired length and hooks bent into shape at its terminals. By immersing all of it but the hooked terminals in nitric

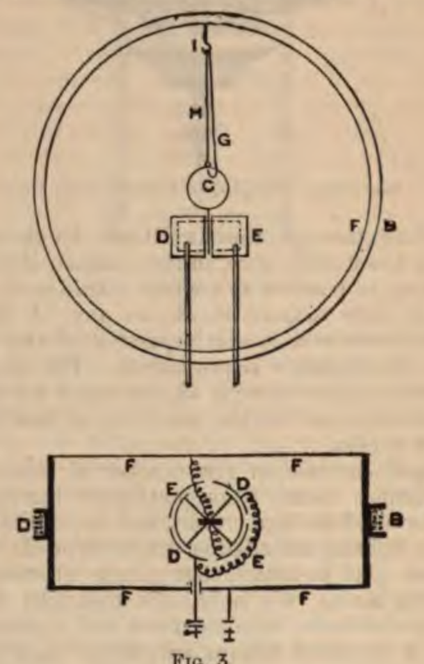

FIG. 3.

acid the silver is dissolved away, leaving the fine platinum core terminated by the two silver hooks. One end of this platinum wire thus prepared is linked into a hook into the top of the electrometer case and the other end into a small ring formed by a twist of the aluminium wire that surrounds the mirror, C. The electrometer case is circular, and the above needle and quadrants are arranged so that the magnetised mirror is at the centre of the case, and the needle and quadrants below it. About the case, as the figure indicates, is wound a coil, BB, of rather fine insulated copper wire. The magnetised mirror and this coil then, when the latter is in the magnetic meridian, constitute an arrangement similar to that of a tangent galvanometer. In the electrometer, the needle, case, and one set of quadrants are connected together, and form one terminal, and the other set of quadrants, being connected together, form the other terminal of the instrument, in the manner set forth in the diagram. Thus then, when the electrometer terminals are subjected to a difference of potential, the needle is acted upon by a couple brought about by the electrostatic forces and is deflected from its position of equilibrium. Then, as is shown in Fig. 3, current from a gravity cell in circuit with a suitable rheostat is sent through the coil on the electrometer in such a direction that the needle is brought toward its zero position by the action of the coil, carrying the current, on the magnetised mirror. The current is then further adjusted till the needle stands balanced at zero under the mutual action of the electrostatic and the electromagnetic forces. Under such circumstances, then, the difference of potential is proportional to the square root of the current.

If we can, as was the case when the measurements here presented were made, consider the E.M.F. of our cell constant, the difference of potential is likewise proportional to the square root of the reciprocal to the total resistance in circuit with the cell. Parallel readings, taken with a standard voltmeter throughout a range varying from three to 600 volts, gave identical results showing no deviation from the above law, and an unvarying constant. On account of the metallic case and its connection to the rest of the apparatus, the indications of the electrometer are, so far as could be observed, entirely independent of the absolute potential to which it is subjected as a whole. In Fig. 2, when contact was made at A and the electrometer charged to the potential difference to which its terminals were then subjected, it was found that considerable of the charge was dissipated by leakage during the course of a revolution of the armature, no matter how good the insulation of the apparatus was. A one-half microfarad mica condenser was then placed in multiple arc with the terminals of the electrometer at C. Then after a few revolutions of the armature the condenser became charged to precisely the same difference of potential existing at the terminals of the electrometer, D, B, as shown in Fig. 3. when the rotating edge on the armature passed the tip of the tongue on the arm at A.

Under these circumstances the leakage that occurred was entirely unobservable as compared with the charge in the condenser during the course of time required for the armature to make many revolutions. Thus arranged, then, the electrometer would give accurate readings of the primary and secondary E.M.F.'s and primary current corresponding to the connection of its terminals and the position of the arm at A. Again, the square root of the mean square of any of these values could at any time be read from the electrometer by short-circuiting the apparatus at A, and cutting out the condenser at C. For the purpose of obtaining the curve of impressed E.M.F. and the $\sqrt{\text{mean}^2}$ of the same, 22 50-volt lamps were put in series across the primary circuit. The $\sqrt{\text{mean}^2}$ of the impressed E.M.F. in the primary was then obtained by reading by means of the electrometer with the condenser cut out, and the commutating apparatus short-circuited, the $\sqrt{\text{mean}^2}$ difference of potential existing between each set of two lamps. In this way 11 readings were obtained, the sum of which was the total impressed E.M.F. This served as a calibration of the non-inductive resistance formed by the lamps. At the same time that these observations were made, two lamps were determined upon to be used in all subsequent observations on the total E.M.F.. The above observations served then as a calibration for the indications of the two lamps thus to be used. For the constant obtained by the ratio of the above total E.M.F. to the E.M.F. of these lamps taken at the same time always served to deduct the total $\sqrt{\text{mean}^2}$ or any particular value corresponding to a particular phase of the impressed primary E.M.F. when the same had been observed with regard to the two lamps in the group thus set apart. In this way we avoided the direct measurements of the total impressed E.M.F.

Two 50-volt lamps, E and F, were placed in series with the primary for a non-inductive resistance, and, as previously stated, the $\sqrt{\text{mean}^2}$ and the values corresponding to any particular phase of the fall of potential through these lamps were observed. This gave a measure of the $\sqrt{\text{mean}^2}$ or any particular value corresponding to a particular phase of the primary current, when the resistance of these lamps was known at the temperature to which they were brought by the current. A curve of resistances corresponding to the range of currents through which we used these lamps was determined carefully by Mr. Merritt at the Cornell Magnetic Observatory.

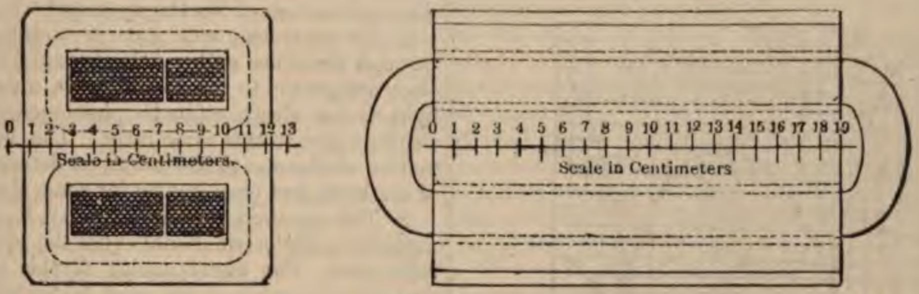

FIG. 4.

In series with the secondary circuit was placed a gravity ammeter containing a few small turns, and correct in its adjustment. It indicated the $\sqrt{\text{mean}^2}$ in the same way that an electro-dynamometer would have done. Observing the various values of the secondary E.M.F. required no special arrangement. This was done directly in all cases. Since the secondary was always at work on a circuit possessing almost no inductance, no determinations of the curve of secondary current made for it would be found to be so nearly in unison with the secondary E.M.F., and possess all the characteristic variations of the same. The $\sqrt{\text{mean}^2}$ of its value was always known from the indications of the ammeter. As a load for the transformer 10 16-c.p. 50-volt lamps were provided that could be turned on and off as desired, and they were at an average distance from the transformer not more than 5ft.

G^1, G^2, G^3, G^4, represent, in Fig. 2, the various terminals conveniently arranged on a switchboard for ready adjustment for any desired set of connections. The adjustable resistance at I consisted of a plug resistance-box enabling one to get any number of ohms in circuit from 100,000 down. It was very conveniently arranged, but a suitable slide rheostat and a damped magnet on the electrometer needle would have facilitated greatly the rapidity with which observations could be taken. The mode of procedure was to set the brush at some suitable point of starting out, then, corresponding to this point, readings of the instantaneous values of primary E.M.F. were made. Then lamps were turned on in the secondary, the ammeter in that circuit was also read. The brush was then moved forward to a new position, and the above readings repeated, This was continued until we had gone over a complete period of two alternations, then the $\sqrt{\text{mean}^2}$ readings of the primary and secondary E.M.F.'s and primary current were made. To do this required a period of time covering usually not more than two and one-half hours. Careful observations were made which showed that the insertion of one, two, or three lamps in the primary circuit did not perceptibly change the relation of the primary E.M.F., and current and secondary E.M.F. The indications of the ammeter gave data for correcting for variations of the speed of the dynamo that throughout was not great.

The following data should be given with regard to the transformer that was used by us:

No. of turns in the primary coil	675.
No. of turns in the secondary coil	35.
Resistance of the primary	21·8 ohms.
Resistance of the secondary	·04 ohm.

Fig. 4 is furnished with a scale to which it was drawn so that from it any details as to dimensions of the transformer can be obtained.

The iron discs of the magnetic circuit of the transformer were made one-half millimetre in thickness, and its surface merely oxidised so that no special insulating material was provided between the laminations. The total volume of laminated iron used in the transformer was 2,050 cu. cms.

The mean cross-section of the magnetic circuit was 63·3 sq. cms., and the mean length of the magnetic circuit 30·8 cms.

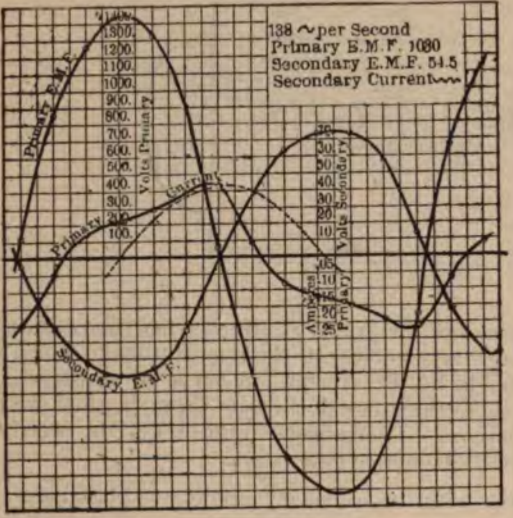

FIG. 5.

The following observations with the secondary on open circuit and working on one lamp, five lamps, and 10 lamps were made and have been plotted in Figs. 5, 6, 7, and 8, the corresponding curves located by them, drawn in by the scales designated.

SECONDARY ON OPEN CIRCUIT.—(*See* FIG. 5).

Brush reading.	Primary E.M.F.	Current.	Secondary E.M.F.
21	119	·20	5·5
20	855	·05	62·7
19	1,250	·07	63·4
18	1,420	·11	70·7
17	1,330	·14	66·8
16	900	·19	46·0
15	45	·21	00·0
14	751	·04	37·8
13	1,210	·08	62·0
12	1,390	·12	72·0
11	1,410	·15	72·5
10	1,100	·18	57·8
9	355	·21	14·5
8	645	·08	32·3
7	1,130	·04	57·8
Observed $\sqrt{\text{mean}^2}$	1,025	·14	54·5
Calculated from curves $\sqrt{\text{mean}^2}$	1,030	·147	53·5

(To be continued.)

REVIEW OF THEORIES OF ELECTRICAL ACTION.*

BY PROF. HENRY S. CARHART.

(Concluded from page 20.)

At this period, sixteen years ago, appeared the epoch-making book of Maxwell on "Electricity and Magnetism." Its author professes only to translate Faraday's ideas into mathematical language; but he did vastly more than this. He demonstrated mathematically that the properties of the medium required to transmit electromagnetic action are identical with those of the luminiferous ether. It would be unphilosophical, he remarks, to fill all space with a new medium whenever any new phenomenon is to be explained; and since two branches of science had independently suggested a medium requiring the same properties to account for the same phenomena in each, the evidence for the existence of a single medium for both kinds of physical phenomena was thereby greatly strengthened. The step from identity of the medium to identity of phenomena—that is, that light itself is an electromagnetic phenomenon—though it may now seem to be a short one, must nevertheless, upon careful consideration, always be accepted as evidence of the greatest genius. To walk in Maxwell's footsteps now and take the very steps he took is one thing and a comparatively easy one; but to make original explorations into unknown regions of nature and to tread where no human being has ever before set foot is quite another thing. The electromagnetic theory of light must be regarded as a great generalisation inferior only to that greatest one of all time—the conservation of energy.

The principal criteria upon which Maxwell relied for the confirmation of his theory may be briefly enumerated:

1. An electromagnetic wave or undulation is propagated through the ether with a velocity equal to the ratio of the electromagnetic to the electrostatic unit of quantity. If light is an electromagnetic phenomenon its velocity must also be equal to this same ratio. The very close approximation of the one to the other, as determined by a variety of methods, has been known for some time.

2. The specific inductive capacity, K, of any transparent medium or dielectric should equal the square of its index of refraction. The discrepancies at this point are so great that all one can say in the most favourable case is that K is the most important term in the expression for the refractive index, while in other cases no confirmation whatever can be drawn from this class of evidence.

3. The magnetic and electric disturbances are both at right angles to the direction of propagation of the wave, and at right angles to each other. The mathematical form of the disturbance agrees with that which constitutes light in being transverse to the direction of propagation. Further, the electric disturbance should be perpendicular to the plane of polarisation of plane polarised light.

4. In non-conductors the disturbance should consist of electric displacements, but in conductors it should give rise to both electric displacements and electric currents by which the undulations are absorbed by the medium. Most transparent bodies, it is true, are good insulators, and all good conductors are opaque. The opacity is, however, far from being proportional to the conductivity.

5. But perhaps the most important criterion of all is the one relating to the very existence itself of a medium. Such a test lies in the time element involved in transmission from point to point. Since energy is transmitted from a luminous body as the source to another one which may absorb it, then, plainly, if time is required for the transmission, the energy must reside in the medium by which the transmission is effected during the interval between the emission and the absorption. In the emission theory the light corpuscles are the receptacles of the energy and carry it with them in their flight. According to the undulatory theory, the medium filling all space is the receptacle of the energy, and passes it along from point to point by the action of contiguous parts. Foucault's *experimentum crucis* proved the emission theory untenable. Roemer's observation of the retardation of the eclipses of Jupiter's satellites when the earth is moving away from Jupiter, is therefore

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*The address delivered to Section B of the American Association for the Advancement of Science.

a confirmation of the undulatory theory of light; and, in consequence, a demonstration of the existence of the luminiferous ether.

At this point the history of the nature of electric action touches upon the third period.

The period upon which we have just entered may not inappropriately be called the period of confirmation. Nothing further appears to be necessary for the complete demonstration and establishment of the electromagnetic theory of light. The noteworthy experiments of Prof. Hertz, of Carlsruhe, are known to all. Rightly conceiving that the reality of electromagnetic waves would be best established by the same experiments which would establish the fundamental identity of such undulations with those of light, he had recourse to the principle of resonance or sympathetic vibrations for the detection of these long-period waves. By a device no less remarkable for its simplicity than its effectiveness, he produced electric oscillations of such rapidity that the waves in the surrounding region were short enough to be measured. This he accomplished by attaching to the secondary terminals of an induction coil two rectangular sheets of metal, each supplied with a short, stout wire ending in a small ball. The balls were brought near each other and the discharges of the coil took place between them. Under these conditions the discharge is oscillatory, and the period may be calculated by the formula of Sir Wm. Thomson published in 1853.*

The receiving apparatus is also of the simplest design, consisting ordinarily of a circle of wire interrupted at a point with an adjustable opening, and of such dimensions that the waves passing through the circle may set up electric oscillations in it synchronising with those of the transmitting apparatus. The passage of sparks across the narrow opening of the circle indicates an electrical flow; and the necessity of adjusting the size of the circle in order to obtain this flow proves that the forces acting are periodic. The receiving apparatus must, in fact, be tuned so that the period of an electrical oscillation in it shall correspond with the external impulses absorbed. The intensity of the electric and magnetic disturbances is indicated by the relative length of sparks obtainable.

Equipped with this apparatus, which was installed in a large lecture hall, Hertz found not only that his tuned receiver responded to the impulses of the transmitter in the precise manner pointed out by theory, but that the sparks showed a series of maximum and minimum values recurring in periodic order as the receiver was carried further away from the source of the disturbance. The astounding fact was thus brought out that these electromagnetic waves were reflected from the thick wall of the room, and that the combination of the direct and reflected systems produced stationary waves, with loops and nodes that could be traced out by the responsive circle of wire. In this manner wave-lengths were measured down to 60cms., and the time element was experimentally detected in the propagation of electrostatic and electrodynamic induction. It was demonstrated that the disturbances producing the waves are at right angles to the direction of propagation, as Maxwell predicted, and as interference phenomena show them to be in light. Hertz has also found an electrodynamic shadow cast by an iron post. He has verified the laws of reflection from plane and concave reflectors, and has shown that electric waves suffer refraction and polarisation in a manner exactly analogous to light. Prof. Fitzgerald, of Dublin, has added another confirmation of Maxwell's doctrine, demonstrating that the electric disturbance is perpendicular to the plane of polarisation, as Maxwell's equations require. Finally, the velocity of propagation of these electrodynamic waves is found to be the same as the velocity of light. Thus not only have all of Maxwell's criteria except the second abundantly confirmed the judgment of the great physicist, but other proofs have been added.

Electromagnetic waves are therefore not only like light, but they are light. Or, perhaps to speak more exactly, all radiant energy is transmitted as electromagnetic waves in the luminiferous ether. Electricity has thus annexed the entire domain of light and radiant heat; and, as Prof. Lodge says, has become a truly imperial realm. The difference of wave-length in the three classes of phenomena is not a fundamental one. Increase the rate of the electrical oscillations a million fold in Hertz's experiments and the waves would not merely resemble light—they would be light. A wire through which such oscillations are surging back and forth would glow with light. Even the long heat waves would be absent and only those producing the sensation of light and colour would remain.

It will be observed that the oscillations of an electric discharge constitute the point of departure for the admirable researches of Hertz; and it is a matter in which we may modestly take a bit of national pride that the first case of electric oscillations was discovered by an American physicist. The oscillatory character of the Leyden jar discharge was demonstrated by Joseph Henry in 1832 by means of the magnetic effects produced in small steel needles. It was not till 21 years later that Sir William Thomson published the complete mathematical theory of such oscillations. They have since been observed directly by means of a rotating mirror. Dr. Oliver Lodge has recently shown that they rotate the plane of polarisation of light in one direction and then the other as they surge back and forth. He has also reduced the number of oscillations from several millions to a few hundred per second by increasing the capacity and the self-induction. The discharge then vibrates within the limits of audibility and produces a musical note.

The well-known experiment of Henry, in which he observed an induction current in a wire stretched parallel to and distant 30ft. from one which served to discharge a Leyden jar, is now known to have been a case of resonance—that is, the absorption of electric waves by a conductor producing currents therein. And it is an evidence of the great genius of Henry that he saw, somewhat dimly it may be, but still with a certain degree of rational apprehension, that the induction was transmitted across the intervening space with a velocity comparable only to that of light. He had perchance the divine touch of genius necessary for the great discovery of electromagnetic waves coursing through the ether; but the way leading to this important physical fact had not then been sufficiently prepared and its discovery was impossible.

Waves similar to those of a Leyden jar discharge but of longer period are sent out from a wire conveying alternating currents. We must conceive of such a wire not simply as affected internally or even superficially by the electric energy surging through it, but as the source from which pulsate outward through the limitless ether great waves of electrodynamic disturbance. For 300 complete alternations per second, these waves are a million metres, or over 600 miles, in length. They present a marked contrast to the waves corresponding to the D lines of the spectrum, which are only about one five-millionth of a millimetre long.

These long waves from an alternating current represent energy. Through space it is conveyed with the velocity of light, and through other non-conductors or dielectrics with a smaller velocity, precisely as in the case of the radiant energy of light or heat. Henceforth the complete equation for the distribution of energy by means of alternating currents must include a term to express the radiation from the circuit. It may indeed be found that this term represents no inconsiderable part of the energy communicated to the wire in the case of very rapid alternations.

Thus we see that the ether plays a magnificent *rôle* in what may be called its dynamic relation to electric displacements. In its capacity as a reservoir of static or potential energy its agency has been better understood for a considerable period. When a continuous current begins to flow through a closed circuit, a single wave travels out from the conductor, and during its progress, while the current is approaching its constant value, the enclosing ether is assuming its condition of static repose under stress. The whole ether, extending indefinitely outward from the conductor, is profoundly modified. We know how to map out the circular lines of force about it by means of iron filings, but the iron serves only to show what has already taken place in the ether before the filings are brought into the field. Every little iron particle becomes a magnet with all the north-seeking poles stretching in one direction round the wire, and all the south-seeking poles in the other. What the mechanism of the stress, or the motion in the ether to produce these effects may be, we do not know; but we do know that these lines of force are all subject to a tension tending to shorten them, and that they are mutually repellant laterally. When a current is sent through a conductor the ether is expanded in concentric cylindrical layers about any straight portions of the circuit, and becomes the reservoir of potential energy. As soon as the current which maintains this state of tension ceases to flow the stretched ether collapses upon the conductor, yielding up its energy in the form of self-induction. If a steady current is conceived as the setting up and breaking down of a static difference of potential at infinitesimal intervals of time, then the energy transmitted may depend upon a similar formation and decay of the static stress in the encompassing ether. The conductor is but the core of an electromagnetic disturbance in the surrounding medium; and it may be that the enormous energy which a small copper wire can apparently convey is in reality transmitted by the invisible medium.

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* Math. and Phys. Papers, vol. i. p. 540.

From this brief review of the theory of electric action it will be quite evident that henceforth the language applied to electrical phenomena must always include as a prominent term the luminiferous ether. The experiments of Hertz have made it impossible to explain electrical facts without taking this invisible medium into account. There is no such thing as electric or magnetic action at a distance. The ether is always an essential part of that complex system the interactions of which manifest themselves as electric or magnetic phenomena.

As the ear responds to the slow oscillations of an electric discharge through the intermediate agency of heat, so the eye of the mind responds to those more rapid oscillations the existence of which has been demonstrated by experiment. No less clearly does the magnetic field appear as a system of lines of stress in the ambient ether. Definiteness has taken the place of the metaphysical speculations of earlier times. Complete ignorance has at least been superseded by half knowledge. We may not yet affirm with Edlund that the ether *is* electricity, but we are doubtless nearer a solution of this old problem than ever before.

"The discord is vanishing slowly,
And melts in the dominant tone.
And they that have heard it can never
Return to confusion again,
Their voices are music for ever,
And join in the mystical strain."

CITY NOTES.

Direct Spanish Telegraph Company, Limited.—The receipts of this Company were £2,187, against £1,908.

Brazilian Submarine Telegraph Company.—The receipts for the week ended January 3 amounted to £4,979.

West Coast of America Telegraph Company.—The receipts for the mouth of December amounted to £6,375.

Eastern Telegraph Company.—The traffic receipts for December were £56,862, as against £59,834 for the same period of 1888, or a decrease of £2,972.

Globe Telegraph and Trust Company, Limited.—An interim dividend of 1s. 9d. per share, payable on the 18th inst., has been declared by this Company.

Eastern Extension Telegraph Company.—This Company's traffic receipts for the month of December were £40,362, as against £38,699 for the same period of 1888.

Direct United States Cable Company, Limited.—For the past three months the Board of this Company have declared a dividend of 3½ per cent. per annum, payable on the 24th inst.

Cuba Submarine Telegraph Company.—The receipts of this Company for December were £3,000, against £3,508. The receipts for September, estimated at £2,400, realised £2,372.

West India and Panama Telegraph Company.—The receipts for the half-month ended December 31 were £2,643, against £2,392. The September receipts, estimated at £4,240, realised £4,256.

Great Northern Telegraph Company.—This Company's taking during December amounted to about 560,000f., and during the whole of last year 6,870,000f., as against 6,805,000f. during the year 1888.

Great Northern Telegraph Company.—The receipts of this Company for December were £22,400, making a total from January 1 of £274,800, against £272,200 and £264,480 for the corresponding periods of 1888 and 1887.

Western and Brazilian Telegraph Company, Limited.—The receipts for the week ended January 3, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,682.

NEW COMPANIES REGISTERED.

Electrical Standardising, Testing, and Training Institution, Limited.—Registered by Slaughter and May, 18, Austinfriars, E.C., with a capital of £10,000, in £5 shares. Object: to establish institutions where electric instruments can be tested. Registered without articles of association.

Syndicate of Electrical Engineers, Limited.—Registered by Slaughter and May, 18, Austinfriars, with a nominal capital of £10,000, in 2,000 shares of £5 each. Object: to establish, maintain, and carry on for profit in England or elsewhere, any standardising, testing, or calibrating institution or institutions where any electric measuring instruments can be tested, calibrated, or standardised; for testing the efficiency of any electric appliances or machinery, either at the institution or institutions or elsewhere; to manufacture any electrical or other instruments or apparatus. The first subscribers are:

	Shares
W. A. Pittman, 7, St. Helens-gardens, W.	1
J. Whitehead, Crouch End, N.	1
T. E. Towerson, F.C.S., 1, Portland-road, N.	1
H. Linklater, 117, Bishopsgate-street, E.C.	1
R. Acock, 117, Bishopsgate-street, E.C.	1
J. A. Loxburgh, 117, Bishopsgate-street, E.C.	1
A. Seligman, 3, Moreton-gardens, South Kensington	1

PROVISIONAL PATENTS, 1890.

JANUARY 1.

10. **Automatic telegraph gear for controlling main engines.** Pearson Fisher and George B. Richards, Crosslands Villa, Barrow-in-Furness.

22. **An improved flower stand and electric light standard combined.** Messrs. Graham and Biddle, 463, Oxford-street, London.

29. **Improvements in the electrical coating of metals on non-metallic substances.** Samuel Victor Dardier, 1, Portland-mansions, Portland-place, West Kensington.

42. **Improvements in the manufacture of cables suitable for the distribution of electric currents.** Willoughby Statham Smith, the younger, 24, Southampton-buildings, London.

JANUARY 2.

58. **An improvement in or connected with incandescent electric lamps.** Henry Gardner, 166, Fleet-street, London. (Wm. Reid, United States.)

61. **Improvements in breech mechanism for ordnance and electric firing arrangements.** George Quick, Hidcote House, Chipping Campden, Gloucestershire.

81. **Improvements in coin-freed apparatus for supplying currents of electricity and other articles or objects.** Henry Sherley Price and Herbert John Dowsing, 115, Cannon-street.

JANUARY 3.

105. **Dynamometer.** James Fraser, 53, Redcliffe-square, South Kensington, London.

113. **Improvements in electric meters.** Walker Moseley, 82 Montpelier-road, Peckham, London.

135. **Improvements in alternate current motors.** Llewelyn Birchall Atkinson, 1, Queen Victoria-street, London.

JANUARY 4.

180. **Improvements in automatic telegraphs.** Edmund Edwards, 35, Southampton-buildings, London. (Edward Cassalette and David Kunhardt, Germany.) (Complete specification.)

SPECIFICATIONS PUBLISHED

1888.

18450. **Dynamo-electric machines.** Johnson (Bradley). 11d.

1889.

915. **Electric switches.** De Ferranti. 8d.
1057. **Electric date, &c., stamps.** Adams-Randall. 11d.
1823. **Telephonic apparatus.** Coleman and Jackson. 8d.
2252. **Measuring electric currents.** King. 6d.
2299. **Measuring electric currents.** Desruelles and Chauvin. 6d.
2413. **Printing telegraphs.** Wright and Moore. 6d.
3130. **Telephonic instruments.** Fraser. 6d.
11615. **Electrical railway conduits.** Reed and McKibbin. 8d.
17118. **Electrical transformers.** Paget and Kintner. 8d.
17781. **Electric switches.** White. 6d.
18010. **Electric lamp holders, &c.** Timmis. 6d.
18051. **Electric signalling.** Lake (Morgan). 1s. 1d.

NOTES.

Acton.—A resolution to oppose the Electric Lighting Bill for Acton was passed at the last meeting of the Local Board.

Frankfort.—The Frankfort Electrical Exhibition is to be held from June 1 to October 31. The exhibition will be upon a very complete scale.

Liverpool.—The electric light company at Liverpool is now supplying, through underground mains, about 7,000 lamps, entirely by meter, upon a sliding scale of charges.

West London Tramways.—The Ealing Local Board have decided unanimously to dissent to the West London Tramways Bill, and, if necessary, oppose it in Parliament.

Society of Arts.—The date of Prof. Silvanus P. Thompson's paper on "The Organisation of Secondary and Technical Education in London" is fixed for February 19th.

Institution.—The next meeting of the Institution will take place on Thursday, the 23rd inst., when the adjourned discussion will be continued upon the president's address on "Magnetism."

Bradford.—A resolution has been adopted by the Bradford Corporation appointing Mr. Sydney Baynes as managing engineer of the electricity works at a salary of £250 per annum.

Dundee.—The applications of Mr. J. K. Caird and Messrs. J. and A. Grimond for permission to run private overhead electric wires over the streets of Dundee was refused by the Council.

Lancaster.—The Lancaster County Council have given their approval to the draft order for the supply of electricity in the lighting of the town, and also to the estimate of approximate cost of the undertaking.

Death of a Pioneer.—Mr. Alfred Cowles, of the Cleveland *Leader* and Chicago *Tribune*, and well known among electricians from his active interest in the electrical extraction of aluminium, died recently at Chicago.

Keswick.—The Keswick electric central station has now been running a week and there has been no hitch of any kind. They have as yet only quarter load on; in a few days it is hoped to test everything under full load.

Elevated Electric Railroad.—The British American Investment Company is backing up a project for the construction of an elevated electric railway in St. Louis. Work is to begin at an early date, as all the capital has been subscribed.

Edinburgh Exhibition.—A correspondent of the *Scotsman* suggests that the delights of the electrical exhibition of Edinburgh should be added to by an historical exhibit celebrating the jubilee of the penny post, as it occurs this year.

Cheltenham.—The minutes of the Electric Light Committee of the Cheltenham Town Council, recommending that the statement of the capital to be deposited with the Board of Trade, being £15,000, were confirmed at the last meeting of the Council.

Thirty Miles an Hour.—The Robinson radial car is in daily use on the Boston and Providence Station and Allston, U.S. The car is 22 feet long and has six wheels. It runs with great smoothness, and covers the ground at the rate of thirty miles an hour.

Leamington.—At the meeting of Leamington Town Council held on Monday the report of the Watch Commitee, which was in favour of a deputation being appointed to visit a number of towns with the view of recommending the best system of lighting, was adopted.

New York Wire Cutting.—During the recent crusade against electric wires in New York there have been removed a total of 472,692ft. of wire and 338 poles. It is stated that the electric light companies will sue the city of New York for £600,000 for cutting their wires.

Pocket Information.—In addition to the list of useful electrical engineering cards published by the General Electric Company and mentioned in these columns some time back, they have now published a card of ceiling roses and pendant accessories, Dovilo volt and ammeters and Edison fittings.

Welding Patents.—It having been stated that the patents of the Thomson European Electric Welding Company would not hold in some European countries, the reply is made by the committee that they are advised by the best of counsel that there is not any doubt as to the legality of the patents.

Purifying Water.—A method of purifying water introduced by the Stanley Electric Company, 904, Walnut-street, Philadelphia, is reported as widely in use for towns and cities in the United States, in conjunction with pumping or filtering machinery. The value of the process is in the destruction of fever microbes.

Atlantic Cables.—The steamship "Faraday" has returned to the Thames, after successfully laying two cables from Nova Scotia to New York for the Western Union Telegraph Company, and repairing the fracture in one of the main Atlantic cables. The second task was performed on the last day of 1889 in stormy weather.

Leather-Covered Pulleys.—Pulleys covered with a broad piece of leather belting laced tightly over them, according to Mr. Schultz, who is introducing the system, will drive 50 per cent. more than iron-faced pulleys, besides allowing the belts to be run slacker, and so avoiding heated journals and wear and tear on the dynamo bearings.

Seamless Rubber Belts.—A rubber belt without seam is now advocated as the ideal driving for dynamos. The belt really consists of two belts which have seams on the inner adjacent side, and which are rolled together and vulcanised, so that when finished the whole makes one solid belt without any seam visible, presenting two perfectly smooth surfaces.

Book Received.—We have received from M. E. Hospitalier a copy of the first volume of his new work on electric energy, entitled "Traité Elementaire de l'Energie Electrique." The book is published by G. Masson, Paris, 120, Boulevard Saint-Germain. It is illustrated with 253 cuts. The second volume, on Industrial Applications, will be published during the year.

Bordeaux.—The work for the electric light at the port of Bordeaux is advancing rapidly. Four towers will be erected 90ft. high, each to support an arc lamp of 4,000 c.p. The lamps will be grouped two in series at the pressure of 110 volts. The current will be supplied by Gramme dynamos, giving 180 amperes and 110 volts at 1,000 revolutions per minute.

Engines.—Messrs. Ransomes, Sims, and Jefferies, Limited, Ipswich, send us their new catalogue, No. 2,356,

E. Continually adding improvements or developing the usefulness of their machinery, this firm has now a most extensive and complete assortment of engines, boilers, and machinery for mining, electric lighting, or other purposes where high-class engines are required.

Southampton.—It has been resolved by the Southampton Town Council to oppose the application of the South of England House-to-House Company, as the Corporation had already given permission to one company to commence operations, and was it thought undesirable to give permission to another. The company already in possession of the field will commence operations in a week or two.

General Post Office.—The authorities at St. Martin's-le-Grand are making rapid headway with the laying of the new installation of electric light for illuminating the whole of the General Post Office, which has hitherto been done by gas. Workmen are just now busily engaged in the different apartments upon the work of fixing the wires in position, and in a few weeks the new light will be ready for use.

Dissolution of Partnership.—The partnership hitherto existing between Mr. J. T. Gent and Mr. H. G. Ellery, trading as Gent and Co., Faraday Works, Leicester, has been dissolved by mutual consent, as from January 1 last. Mr. J. T. Gent, at the same time, has taken into partnership Mr. A. W. Staveley and Mr. I. H. Parsons, and the business will be continued under the usual style of Gent and Co., electricians.

Edinburgh.—At a meeting of the Edinburgh and District Water Trust, the clerk stated that he had received a draft of a provisional order to authorise the Scottish Electric Supply Company, Limited, to supply electricity for public and private purposes within the city and Royal burgh of Edinburgh, along with a letter from Messrs. J. K. and W. P. Lindsay, W.S., with reference thereto. The documents were remitted to the Law and Works Committee.

Indian Tramway.—A tramway is shortly to be started in Hyderabad connecting Secunderabad and Chudderghat with that city. It will be the work of a company promoted by Mr. Berkley, locomotive superintendent of the Nizam's railway. The power to be used is not stated, and it might possibly be a good opportunity of insisting upon the merits of electric traction. There must be a very wide field for electric tramways in India, and a successful one once started would induce many followers.

Canford House.—The seat of Lord Wimborne, Canford House, visited by the Prince of Wales, and Prince George and party, has been splendidly redecorated at a cost of many thousands of pounds, and has been fitted throughout with the electric light, about 1,000 lamps having been put in, and of these there are nearly 400 in the great hall, which is used as a ballroom. In the staircase and other woodwork of this hall there are some very fine specimens of art carving. The electricity for the lamps is supplied from storage batteries charged from two large dynamos, which are driven by two 16h.p. engines.

Electrical Fittings.—Messrs. Fowler, Lancaster, and Co., who have lately formed themselves into a private limited company, send us their catalogue of electrical bell and other fittings. This firm have taken the agency and manufacture of Snelgrove's adjustable electric bell, which *obtained the only gold medal* for bells at Birmingham, and of Leonardt's electric water level alarm. The catalogue contains numerous varieties of batteries for telegraph or bell work, pushes, fire and burglar alarms, watchman's time controllers; batteries for cautery, laryngoscopic work and dentistry, and other similar electric apparatus.

Notting Hill.—The Notting Hill Electric Lighting Company, whose stock to the extent of 9,314 £10 shares have just been offered to the public, have secured a convenient site for the central station at Victoria-gardens, Notting Hill, within the area of supply. The current will be supplied on the low-tension accumulator system, and will be on night and day. The attempt has been made to obtain as many shareholders in the district as possible so as to make the affair to a great extent co-operative. Several of the directors, and among them, Mr. William Crookes, F.R.S., the chairman, reside in the district.

Electrical Supply.—If anyone wishes to see what the ideal electric supply catologue should be, they might do worse than go for such information to the Electrical Supply Company of Chicago, who issue a book full of really good cuts, carefully printed on good paper, with a neat, unostentatious, and yet artistic cover, making it look almost equal to an illustrated monthly. Inside it is quite a thick book, 320 pages, and contains details of supplies of every sort and equality, well described and displayed. A number of tables of sizes of conductors, wiring tables, formulæ, and rules for wiring make the book very complete, and a credit to our transatlantic electrical cousins.

Floral Fittings.—We have received an advance copy of the catalogue of Messrs. Lea, Sons, and Co., Pengwerne Works, Shrewsbury, who are justly celebrated for the beauty and delicacy of their metalli-floral fittings imitated after natural flowers. Several samples of these fittings are illustrated in tints, the wrought-iron wreathed brackets being particularly effective. The firm are also large makers of moulded, cut and florally decorated glass shades for electric light, of which many very pretty designs are shown, as well as a number of brass fittings specially designed for cut-glass work. The wrought natural floral metal-work is, however, their speciality, and deserves attention by those who are fitting up good houses.

Abandonment of Orders.—The Electricity Supply Corporation has abandoned their proposed order, of which official notice had been given to the Board of Trade, for powers to light "the whole of the parish of Paddington," thus leaving the order deposited by the House-to-House Electric Supply Company for the lighting of that parish unopposed so far as this corporation are concerned. The same corporation have also abandoned their proposed order for the lighting of "the whole of the district of St. Giles' District Board of Works and the district of the Strand Board of Works." These were the only two orders for the electric lighting of London of which notice had been given by this corporation.

Distribution at 4,000 Volts.—The Westinghouse Electric Company, of Pittsburg, U.S., has just closed an important contract with the Wellamette Light Company, of Portland, Oregon. The company is to furnish 10,000 incandescent and 100 arc lamps, together with the wire and machinery necessary for operating the same. The current is to be carried 12 miles before being distributed, a thing never before attempted in that country. For that purpose a specially-constructed machine, capable of producing 4,000 volts, is to be used. The cost of the entire plant, including the distributing station building, will be in the neighbourhood of 200,000dols. The completion of this plant will be the inauguration of electric lighting in that city.

Fareham.—Mr. Blake, as the promoter of the Fareham Electric Light Company, asked permission of the Fareham Local Board to erect posts and wires in the town for the purpose of supplying the electric light. The speaker alluded at length to the objects of the company and to the requirements of the Board of Trade, all of which they intended to carry out. Mr. Appleby enquired whether, if any other company was formed, would the Board grant permission to erect wires, or whether the Board felt inclined to take up the question of electric lighting. The chairman, Mr. T. Hewitt, said he had been spoken to by several ratepayers upon the subject, and many objected to the wires being placed overhead. He thought more consideration should be given to the matter. The application, however, was granted.

Steam Navigation on the Nile.—A new Egyptian association has been formed, styled the "Thewfikieh" Company, who are the owners of a number of steamers which have been specially fitted for a regular service of passengers desiring to ascend the river from Cairo to the first cataract, visiting the antiquities on the banks. The formation of this company has been sanctioned by a decree of the Khedive, who has just inaugurated the operations by a personal visit on board the steamer "El Khedevie." The saloon, ladies' boudoir, smoking-room, and all parts of the steamer are illuminated by 80 electric lights of a total power of 2,500 candles, and the decorations of the apartments are of the most elegant and luxurious character. Messrs. H. Gaze and Son are appointed agents in Europe, Egypt, and America for the company.

Cantor Lectures. — Prof. Silvanus P. Thompson will deliver four lectures before the Society of Arts on "The Electromagnet" on Monday evenings at eight o'clock. The following are the dates and subjects of the lectures: Lecture I., Jan. 20.—Introductory: Historical; uses and forms of electromagnets; magnetic properties of iron—induction, permeability, hysteresis. II., Jan. 27.—Principle of the magnetic circuit: experimental data; predetermination of iron and copper for given traction; heating of coils. III., Feb. 3.—Special designs: various forms and uses; electromagnets for quickest action, longest range, maximum traction, minimum weight; for alternate currents series and parallel work. IV., Feb. 10.—Electromagnetic mechanism: range of action of various forms of electromagnets; plunger and coil; equalisers: modes of preventing sparking.

City Lighting.—At the meeting of the City Commissioners of Sewers, on Tuesday, applications were received from the London Electric Supply Corporation and the Metropolitan Electric Supply Company for the consent of the Commission to their application for provisional orders under the Electric Lighting Acts. Mr. Rose-Innes moved that the applications lie upon the table. He said they had already settled the matter so far as the Brush Company was concerned, and they had given them a contract to carry out the electric lighting on the terms arranged by the Streets Committee. It would be most unfair to the contracting company if they agreed to these fresh applications seeking parliamentary powers over the City, and he urged the Commission not to give out of their own hands the provision of electric lighting in the City. After a discussion the motion was adopted.

Hertford.—The people of Hertford are not unlikely to have the electric light supplied to them before long. A number of the leading gentlemen of the town met last week, and resolved to form an electric lighting company, with a capital of £20,000, one half of which only should be raised at present. A confident feeling appeared to prevail, those present believing that a good income could be secured if the matter were carried out properly. A strong committee was accordingly formed to proceed with the preliminary details, and the required capital, it is said, can be obtained without difficulty. The question is now being raised in the district, if a public company can supply electricity at a price that will compete with gas, why should the consumers, who are the inhabitants at large, not do it for themselves? The result may possibly be here, as in other instances, that the local authorities will take some steps to keep the lighting in public hands.

Double Carbon Arc Lamps.—The case has just been decided in the American courts in favour of Mr. Charles F. Brush for the patent for the use of double carbons in arc lamps. The result is a curious illustration of how business tends to be worked in the States. The suit was brought by the Brush Company against the Fort Wayne Electric Company, who allied with the Thomson-Houston Company. Since then the all-reaching Thomson-Houston have bought up the Brush Company, works, goodwill, and suit included. The loss of the case by the Fort Wayne Company is therefore really better for them than if they had gained, for as the judge's decision is in favour of the Brush patents, of which combination they now form part, it will give them the use of the double arc lamps against their competitors. It is thought the decision will practically give the combination control of the whole of the all-night lighting in the country, and is said to be worth £200,000 to the gainers of the suit.

The late Don Lucas Mariano de Tornos.—The Spanish Telegraph Corps has had a most unfortunate experience of the epidemic which has lately swept through Spain, having suffered the loss of several officials. Among the distinguished members of the service who have fallen victims to the prevailing malady, we have, with great regret, to chronicle the death of Don Lucas Mariano de Tornos. The name of this gentleman will be remembered by our readers chiefly in connection with the Telegraph Conference of Paris, St. Petersburg, Berlin, and Vienna, at which he held an important position in the representation of his Government; he also represented the Spanish Telegraph Bureau at the conferences held in Paris upon the protection of submarine cables. The possession of great tact and judgment, in addition to a thorough knowledge of telegraph technicalities, rendered him of peculiar service to his department in dealing with the telegraph administrations of other countries. He was the representative in Madrid of the Spanish National Submarine Telegraph Company, a position he filled with marked intelligence and ability. The news of the demise of Don Lucas de Tornos will be deeply regretted, not alone by those who have met him in an official capacity, but to a greater degree, even by those who, strangers to Madrid, will recollect the many kindnesses and thoughtful consideration experienced at his hands.

Aberdeen.—The monthly meeting of the Aberdeen Town Council held the other day was remarkable for a statement of Mr. Cook to the Council as to the retrograde movement of electric lighting in America, which it may perhaps be as well to put on record, and at the same time categorically to contradict. In answer to the Lord Provost with reference to the deputation upon the subject of electric lighting, Mr. Cook said, "He considered that the deputation had arrived at the true state of matters with regard to electric lighting. They would have observed that in America electric lighting had been gradually growing out of late, and that parties were returning to gaslight, and he thought there could be no greater proof shown of the practical results of the deputation's visit to the south than such things as had been going on in America, where they had been trying electric lighting on a much larger scale than in this country." It is certainly not the case that the American cities are returning to gas, yet on the strength of this, and on the result of conversations with persons "connected with electric lighting in a practical way," he argued that the Bill should be blocked. He thought what the Gas Committee had recommended was what they ought to do as a sensible body; they ought to obtain powers themselves within a given time. These powers did not compel them to do anything at all; they could simply abandon the Bill, and do what they thought proper when the time came.

Woking.—The Woking local sanitary authority at their last meeting considered the application of the Electric Supply Company for powers to supply electricity and to lay down mains, etc., in the parish of Woking. The chairman stated that the question as to overhead wires for electric lighting was now before the County Council. They had all seen in the papers lately that a great many accidents had occurred in all parts of the world from the breakage of these wires, and there was no doubt a considerable amount of danger. He believed the County Council at its next meeting would pass a resolution, ordering that all wires for electric lighting must be carried underground to ensure the public safety. Mr. Bayliss asked if there was not a gas company already formed for Woking? The chairman believed the time allowed had expired; but if the gas company had any idea of carrying out their original intentions no doubt they would be strong oppositionists to the electric company obtaining their order. Mr. Wermig believed that if it had not been for the talk of the electric lighting company they would have had gas in Woking before now. Mr. Bayliss moved that the Rural Sanitary Authority be informed that the Vestry did not consider it desirable at present that the electric light should be supplied at Woking either overhead or underground. Mr. Vincent seconded. The chairman said that, with all due deference to the gas company shareholders, there was not the slightest doubt but that the electric light was the light for the future, and the near future. The motion against was lost by the casting vote of the chairman. He added that if the Electric Supply Company did not prove a financial success, that was a matter which would not affect the ratepayers. A motion was then proposed that it was undesirable that the electric wires should be carried overhead. This was unanimously agreed to.

Experiments with Accumulators.—The following abstract of an account of experiments by W. Kohlrausch and C. Heim is given in the *Journal* of the Electrical Engineers, from the *Electrotechnische Zeitschrift*, p. 303, 1889: The two cells on which the experiments were carried out had formed part of a battery which had been in daily use from October, 1882, till December, 1887. Each cell contained three positive and four negative plates; the surface of each plate was 36 square dm., and the liquid was dilute sulphuric acid of specific gravity 1·115, the quantity being 3·4 litres. The cell, when ready for working, weighed about 20 kg. The capacity of each cell was 45 ampere-hours, the normal charging current was five amperes, and the discharge current 6·5 amperes. With the normal current the E.M.F. rises on charging from 2·09 to 2·1 volts at the end of half an hour, then falls again to 2·085, rising at the end of four hours to 2·09, and then increases steadily till the end of the eighth hour, when it rises rapidly, finally touching 2·34 volts. On discharging with a normal current the E.M.F. first rises slightly from 1·922 to 1·928, and only again reaches its former value after about one and a half hours; it then falls off very regularly till the end of the discharge. The remarkable rise of both curves should probably be attributed to some kind of secondary action. The resistance was very carefully measured, and was found to be proportional to the charge and to the discharge respectively. The density of the acid was taken regularly, and found to be directly proportional to the state of charge of the cell; it varied from 1·115 to 1·147. This value agrees extremely well with the value arrived at from theoretical calculations, these giving 1·146, from which the observed value differed only by the third decimal place. A considerable number of further experiments were made with currents exceeding the normal, the detailed results of which are all given in the paper.

Electrical Engineering Corporation.—An amalgamation, for which our readers will not be unprepared, has been arranged between Messrs. J. G. Statter and Co., Limited, and the United Electrical Engineering Company, Limited. It has been well known to the electrical profession that the latter company have acted as London agents for Messrs. J. G. Statter and Co., Limited, during the past year, and with the now daily increasing volume of business it has been felt by the managing directors of the two companies that there existed a special fitness for amalgamation. The amalgamation has been effected upon a sound business basis, and the new company has taken over the interests and responsibilities of both companies at and from the 1st inst., under the name of the Electrical Engineering Corporation, Limited. The corporation is thus a manufacturing and supply undertaking having exceptional facilities for co-operating with contractors and others in carrying out work at home and abroad in all branches of the electrical industries. The Alliance Engineering Works are favourably situated at West Drayton, within 15 miles of London, on the main line of the Great Western Railway, and have a dock and wharf upon the Grand Junction Canal. The works are already extensive and complete, and when the extensive works in progress have been completed they will cover about four acres of ground, and contain some of the largest machine tools employed in the trade. The situation of the works is favourable for the economical dispatch of material both for home and foreign use, and may be easily reached from all parts by those desirous of inspecting machinery before leaving the works. The Albert Works at 36, Albert-embankment, S.E., are devoted to the manufacture of heavy switches, safety junction and regulator gear, together with other fittings and accessories of electrical work. The London offices will be, as before, at Prince's-mansions, 68, Victoria-street. The managing directors of the corporation are Messrs. J. G. Statter, Edward Manville, and W. L. Madgen. The new corporation starts work under the best auspices, and at a period when electrical work is pouring in on all sides, and we wish them the heartiest success.

Formation of Company at Birmingham.—Birmingham has now its electric light company, and seems within measurable distance of soon possessing its central electric station. The provisional order obtained last session by Messrs. Chamberlain and Hookham for the supply of electricity within a certain area of Birmingham was made over some time ago to Mr. A. Bromley Holmes, M.I.C.E., and Mr. J. Clough Vaudrey, M.I.C.E., engineers of the Liverpool Electric Supply Company, for £3,000. A company has now been formed under the title of the Birmingham Electric Supply Company, to whom Messrs. Holmes and Vaudrey have agreed to sell the concession at the price they paid for it. This company has an entirely local directorate, consisting of Messrs. H. Buckley (chairman of the Assay Office), G. S. Albright, J. F. Albright, G. H. Johnstone, and F. W. V. Mitchell, with Mr. Vaudrey as managing director, and Mr. Holmes as consulting engineer; and Messrs. Smith, Pinsent, and Co. as solicitors. The nominal capital of the company is £100,000, in 20,000 shares of £5 each. The only contracts entered into on behalf of the company are those relating to the purchase of the concession, and it is stated in the prospectus that no promotion money has been or will be paid. Assuming that there will be no difficulty in floating the company, it is estimated by Mr. Vaudrey that, in at least a considerable portion of the area, the light will be available before next winter. The area to which the provisional order related is a central one, the main portion of it being bounded by and including New-street, Paradise-street, Easy-row, Edmund-street, Livery-street, Monmouth-street, Bull-street, High-street, Bell-street, and Worcester-street, with one extension to the Aston end of Corporation-street; and another bounded by and including Albert-street, Fazeley-street, Bordesley-street, Paternoster-row, and Carr's-lane. For the offices, shops, and other business premises in the principal commercial streets of the city, therefore, the electric light will be available, and the area includes nearly all the principal public buildings, educational institutions, and hotels. The electricity for this area will be generated at one station, the plant for which will consist of dynamos driven by sets of steam-engines and boilers so arranged that no accident can interfere with the continuity and uniformity of the supply. The configuration of the area is such that no part of it will be more than 500 yards away from the source of supply. The pressure to be used is not over 150 volts. Under the provisional order the company will be bound to deliver electricity within this area wherever there may be a demand for it. Consequently, the directors, while they propose to construct and equip at once a central station sufficient to provide for 5,000 16-c.p. or 10,000 8-c.p. incandescent lamps, will have to lay mains in all the principal streets sufficient for a considerably larger supply. The initial outlay in these respects is estimated at £30,000. Another of the conditions of the provisional order is that an uninterrupted day and night service shall be given. Ultimately it is hoped that in this area something like 20,000 lights will be supplied.

Bath Central Station.—The electric light central station in Bath, situated on the site of the Old City Flour Mills, Dorchester-street, is being rapidly pushed forward, and it is expected that by March next some 4,000 incandescent and 200 arc lamps, distributed over 60 of the principal streets, squares, and crescents of the city, will be supplied from it. The installation bids fair to be an interesting one, and another feather in the cap of Mr. Massingham, the designer and moving spirit. It is through this enterprising gentleman that the West of England has, to a certain extent, become the pioneer of electric lighting from central stations in England, the installations in Exeter and Taunton, now so well known, having been started and carried through by him. The machinery and plant now being fixed at Bath are of the same type as that in use at Exeter and Taunton, and consist of two Babcock and Wilcox patent water-tube boilers, each of 150 h.p., supplying steam to six compound condensing engines. Four of these engines, each indicating 35 h.p., will drive the arc light dynamos; and the two larger engines, each capable of developing 150 h.p., will supply power to two large Mordey alternators, working at 2,000 volts. The cables are underground, and when complete a total length of some 40 miles will be laid. The laying of the cables is being carried out by Mr. W. D. Reid, for the Callender Company. They are laid under the footway in cast-iron troughs about 5in. wide. The arc lighting circuit consists of 7/16 heavily insulated cables, while for the incandescent circuit 19/17 is used. The troughs are of sufficient width to take four of these cables packed side by side, but kept apart by wooden separators, or bridges, placed at intervals of a few inches. The spaces between the cables and trough are then filled in with bitumen poured on in a liquid state, which, on solidifying, encases the cables in a solid damp-proof mass, in the centre of which the conductors are buried. The troughs are of sufficient depth to take two layers, or eight cables, or less number, according to requirement of the districts. The arc lamps in each street will be arranged to be fed from two distinct circuits, each supplied by separate engines and dynamos, and in the event of one circuit failing only the lamps on one side of the street would be effected. Two main circuits will be run through the town. From these circuits branches will lead east and west through the intervening streets. The arc lamps are to be carried on lampposts 23ft. from the ground, overhanging 2ft. into the road. The engine-room is of ample size, 150ft. long by 40ft. wide, and the plant at present being fitted there will only occupy one-third of this space. This plant will supply 200 arc lamps each of 1,200 c.p., and 8,000 incandescent lamps. When the plant is completed, and extra boiler-house added, 600 arc lamps can be supplied and 30,000 incandescent. The whole of the engines, the alternate-current dynamos, and transformers are being supplied and fixed by the Brush Electrical Engineering Company, Limited, under the superintendence of Mr. Sulman, and Messrs. Laing, Wharton, and Down are supplying the four Thomson-Houston arc dynamos and lamps. The installation is being carried out solely by Mr. Massingham, who has obtained from the Corporation a seven years' contract for lighting 59 of the principal streets with Thomson-Houston arc lamps, and who has also undertaken to supply private consumers throughout the whole of this district. The cost of this installation will be about £25,000, and it is the largest public lighting contract yet attempted in the United Kingdom. The charges to private consumers will be 10s. per annum for each lamp of 10 c.p., burning any hours required. All other lamps will be charged in same proportion—viz., 1s. per candle per annum. This is a lower price than is being charged in any town in the United Kingdom, with the exception of Exeter and Taunton, where the price is the same, and even less than is being charged in America and on the Continent. The work is rapidly progressing, and the inhabitants of Bath will soon be able to boast another attraction.

BELTS, PULLEYS, AND SHAFTING.

In an electric light installation, when once the type of engine and dynamo are determined upon, these are ordered of the manufacturer, and supplied ready for fixing. The details of gearing then become the next important consideration, for the proper running of the installation and its maintenance in proper condition is an all-important part of the engineer's duties—for failure of gearing means stoppage of the dynamo. The following chapter upon belts, pulleys, and shafting is taken from a little book for dynamo-minders, which is to appear shortly.

Special Dynamo Room.—It is better under all circumstances to have a room specially set apart for the dynamos and engines. The room should be dry and free from dust. Better too much elbow room than too little. As the dynamo usually runs faster than the engine, the driving pulley of the engine is connected to the pulley of the dynamo by means of belts and intermediate shafting.

Direct Gearing.—For ship lighting, however, and in places where room is of great importance, fast-speed engines are geared direct to the armature of specially designed slow-speed dynamos, and in these cases no belt or shafting is required. When driving by the aid of a belt, the belt should not be too short, as a short belt slips more than a long one, and it will be safe to allow at least 2 per cent. for slips when calculating the size of the pulleys. With direct-geared dynamos the minder has no trouble about his pulleys, but it may be different when belting is employed.

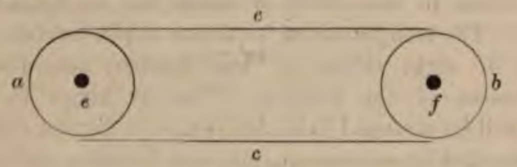

FIG. 1.

Belting.—Let *e* and *f* (Fig. 1) be parallel shafts some distance apart. If pulleys, *a*, *b*, of equal diameter be keyed on the shafts, with a belt, *cc*, going round each, then rotary motion being given to *a*, the friction between the strap and the pulley puts the strap into motion, and the motion is conveyed in the same direction to the pulley on shaft *b*; the velocity of *b*, neglecting slip, is the same as for *a*. When the motion is to be reversed the strap must be crossed. When a different angular velocity of rotation is desired the pulleys are of different sizes. If the circumference of the driving pulley is 6ft., and that of the driven pulley 3ft., since the belt travels at the same rate as the circumference of the driving pulley and causes the driving pulley to move at the same rate, it is clear that the latter makes two revolutions while the former makes one—or the angular velocity of the smaller pulley is double that of the larger. The circumferences of circular pulleys are exactly proportional to their diameters, so that the angular velocities of pulleys connected with straps are inversely as their diameters, or, as it is more frequently put, inversely as their radii. Generally the engine speed is known and the diameter of the driving wheel. Let these be represented by S = speed, D = diameter. Also the speed at which the dynamo is to be run is known, then to find size of pulley let s = speed, d = diameter—that is, the products of the respective speeds multiplied by the respective diameters are equal.

$$\mathrm{S\,D} = s\,d$$

$$\text{or } d = \frac{\mathrm{S\,D}}{s}.$$

An engine making 125 revolutions a minute with a driving pulley 6ft. diameter, would drive a dynamo 1,500 revolutions a minute with a pulley ·5ft. diameter, for

$$\begin{array}{ccccccc} \mathrm{S} & \times\,\mathrm{D} & & s & \times & d & \\ 125 & \times\ 6 & = & 1{,}500 & \times & \cdot 5 & = 750. \end{array}$$

If there is a train of pulleys it is not necessary to make separate calculations; the whole may be done at one operation. Thus, to find the final speed with driver A, 24in. diameter, revolving at rate of 10 revolutions a minute, driving B, 12in. diameter, on same shaft as B is C, 36in. diameter, revolving at same speed as B, and driving D, 12in. diameter. On same shaft as D is E, 27in. diameter, driving F, 9in. diameter, what is the speed of F. Here, again, $\mathrm{S\,D} = s\,d = s'\,d' = s''\,d''$.

Working separately we get

$$\frac{10 \times 24}{12} = 20 = \text{speed of B} \;.\because\text{ also } 20 = \text{speed of C.}$$

$$\frac{20 \times 36}{12} = 60 = \text{speed of D} \;.\because\text{ also } 60 = \text{speed of E.}$$

$$\frac{60 \times 27}{9} = 180 = \text{speed of F.}$$

or, at one operation,

$$\frac{10 \times 24 \times 36 \times 27}{12 \times 12 \times 9} = 180 = \text{speed of F.}$$

By taking the radii instead of the diameters, the result comes to the same, and we have to use lesser numbers, thus:

$$\frac{10 \times 12 \times 18 \times 13{\cdot}5}{6 \times 6 \times 4{\cdot}5} = 180 = \text{speed of F.}$$

that is, revol. first driven × diameter of all driven ÷ dia. of all driven gives speed of last driving pulley.

The effective radius is the radius of the pulley added to half the thickness of the belt.

Belts which are mostly used require nearly cylindrical pulleys, while cords require cylindrical drums with ledges or grooves. As belts tend to move towards the part of the pulley with greater radius, it is customary for pulleys to be made slightly swelled out in the middle so that the belt should remain on. The lower side of the belt should be made the driving side, because better contact is made by the sagging of the following side—*i.e.*, the belt is more likely to cling round a larger arc of the pulley. The proportion between the diameters of two pulleys working together should not exceed 6 to 1, and the convexity of the pulley to receive belt should be = ½in. per foot wide. The width of the pulley should be 1·2 that of the belt. The speed of the belt should not exceed more than about 4,000ft. per minute; 3,500ft. for main belts is good practice, though higher speeds are frequently indulged in.

When the axes of a pair of pulleys are not parallel, the belt should be so placed that the part of the belt which is *approaching* the pulley shall be in the plane of the pulley.

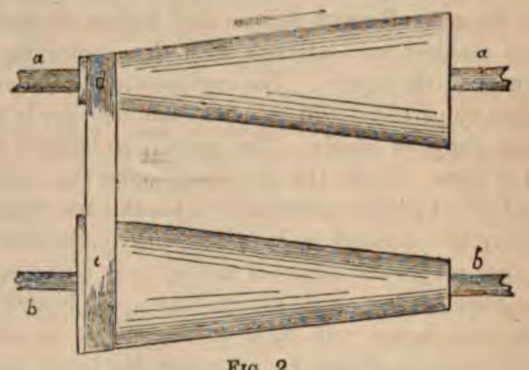

FIG. 2.

When the velocity ratio is required to be variable speed cones are used. They are either continuous cones or conoids, or compound pulleys with steps of different radii, as shown in Figs. 2 and 3.

To get a belt off a pulley *press against* it on that *side moving towards* the pulley.

A dressing of castor oil occasionally is an excellent plan for preserving belts and keeping them in good working order.

The coefficient of friction between ordinary leather belts and cast-iron pulleys is = ·423. The strength of such belts = about 3,000lb. per square inch.

To calculate the power a belt will transmit, the following formula may be used and will give good practical results when the pulleys are not very unequal. When H P = horse-power, W = width of belt, F = driving force, T = working tension from 70 to 150lb., V = velocity of belt in feet per second.

$$F = \frac{W \times T}{2}.$$

$$H\,P = \frac{V \times F}{33{,}000},$$

$$W = \frac{33{,}000 \times H\,P}{F \times V}.$$

Example.—What horse-power will a 10in. belt running 3,000ft. per minute transmit, the working tension being 100lb.

$$F = \frac{10 \times 100}{2} = 500.$$

$$H\,P = \frac{3{,}000 \times 500}{33{,}000} = 45{\cdot}45.$$

Nystrom gives this formula: $H\,P = \frac{V \times F}{550}$ when V = velocity in feet per second, and F = force in pounds transmitted by belt.

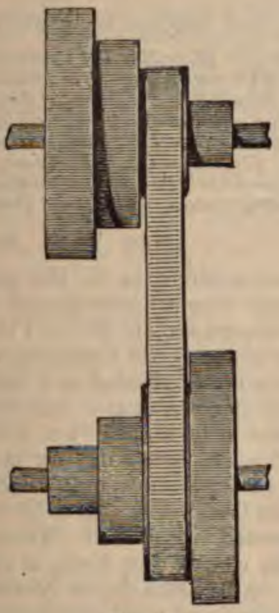

FIG. 3.

Double belts transmit $1\frac{1}{2}$ times as much as single belts.

FRICTION.

Shafting and Spindles.—We shall assume here that all shafts and spindles are properly made and fixed, that the bearings are good and sufficient, and that the clutches are suitable. These all form parts of the work of the original design. The most important part of the minder's duty is to attend to the lubrication of the bearings. In all cases where possible sight-feed lubricators should be used.

Friction.—When an attempt is made to slide one body over another it is found that it is necessary to apply some force, and the amount of force so applied differs according to the nature of the bodies and the condition of the surfaces in contact. The resistance offered to the sliding is called friction. Except in a few instances, such as in transmitting power by means of pulleys and belts, in stopping motion by means of brakes, when friction is usefully employed, we want as little of it as possible, and the efforts of the machine minder must be directed to reduce the friction of all moving parts upon their bearings to a minimum. Although this resistance cannot be wholly overcome, careful design, good workmanship, with the proper selection of materials, and due provision of lubricating materials, it may be diminished to a very great extent. A large number of experiments have been carried out by various people to determine the amount of resistance due to friction. It is easy to get an idea by means of a simple experiment of frictional resistance.

Suppose A, Fig. 4 to be a piece of material, such as iron, wood, brass, or the like, having a smooth lower surface in contact with a smooth table, B, of the same or any other material. The weight of A presses it perpendicularly downwards in the direction C, and to move it laterally some force, D, will have to be impressed. If the force D acts in the direction as shown by the arrow, it is opposed by a force, E, in the opposite direction, as shown by the arrow E. The resisting force E is the friction between the surfaces A and B. Now suppose B tilted up, there will be a point of tilt when A will begin to slide by its own weight. The greatest angle at which the plane will support the body is termed the *angle of repose*, or limiting angle of resistance. If we take a line F G to represent the weight of the body this may be decomposed into two forces, F H, representing the resistance of the plane, and G H representing the resistance of friction, for this force is that which tends to make the body slide, and if the position is at the angle of repose, it, as we say, represents the frictional resistance. The ratio of G H to F H, or $\frac{G\,H}{F\,H}$ is termed the *coefficient of friction*. Mathematicians may put this as the tangent if the angle of repose gives the coefficient of friction. Carry the experiment a little further, and if it be with iron on iron put some suitable lubricating material upon the surfaces in contact and you will find the weight begin to slide before the plane B has reached the tilt it had originally.

The following are the laws of friction as generally stated, but they must be taken as approximately correct only:

1. Friction is proportional to the pressure.
2. It is independent of the extent of surfaces in contact.
3. In cases of motion it is independent of velocity.
4. If unguents—that is, lubricants—are used, friction depends on the nature and amount of the lubricant.

As an example of the use of the coefficient of friction, take the case of brass and iron, for which the coefficient is ·142 and the limiting angle 8deg. If, then, 1cwt. smooth iron rested on a horizontal brass plate, it would require a lateral force of 112 × ·142 = 16lb. to move it. Or, take a smooth round steel shaft weighing one ton, revolving in a brass bearing. The force necessary to be applied at the circumference of the shaft to overcome friction will be 2240 × 142 = 320lb. Assuming the shaft to have a radius of 3in. at the bearing, this length is the leverage at which the friction acts to resist rotation, and the resistance, 320lb., at this leverage is equal to $320 \times \frac{3}{12} = 80$lb. applied at radius 1ft.

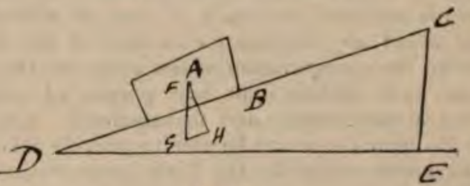

FIG. 4.

When surfaces are rough the resistance is increased, and they are liable to become rough by wear and tear, or the presence of grit. Inattention, or faulty lubrication, or dirt means increasing roughness and consequent loss.

Rubbing surfaces should fit accurately. Friction is generally greater when the rubbing surfaces are alike than when they are different. In cases where great pressure is sustained on a bearing, the surfaces of contact should be extended as much as possible. The resultant action of friction is to produce heat, and all such heat unnecessarily produced has to be made good in the furnace at the cost of the coal and wages bill. If, then, a bearing constantly heats, and it is found due to too small a surface contact, increase the length of the bearing. It is important that the lubricant be properly distributed over the surface, just enough be used, or money will go for waste lubricant instead of waste coal. For very heavy bearings solid lubricants are used, such as tallow, mixtures of sulphur and tallow, asbestos, soapstone and asbestos, graphite, caustic soda, beeswax, etc. It will easily be seen that both pressure and velocity must be taken into account in determining the lubricant. The maximum pressure that solid lubricants will bear is unknown. Thurston says good lubricants should have the following characteristics: (1) Sufficient "body" to keep the surfaces apart; (2) the greatest fluidity consistent with (1); (3) a minimum coefficient of friction; (4) a maximum capacity for receiving and distributing heat; (5) freedom from tendency to "gum" or oxidise; (6) absence of acid or aught likely to be injurious to whatever is in contact with it; (7) high vaporisation and decomposition temperature with low solidification temperature.

(*To be continued.*)

ELECTRIC LIGHTING BY THE GAS COMPANY AT TOULOUSE.

A central electric lighting station was opened at Toulouse on the 30th December last with complete success by the gas company of Toulouse—Compagnie du Centre et du Midi—under the direction of M. Brouardel.

This company has already lighted the Capitol by means of two gas-engines of 50 h.p. each, and two Breguet dynamos, each capable of supplying 500 lamps; but having contracted for the lighting during this year of the Théâtre des Variétés with about 500 lamps, they wisely decided to extend the supply to private customers by putting down at the same time plant for 500 other lamps as the commencement of a central station.

After having considered the report of a technical committee composed of MM. Mascart, Sartiaux, and Vigreux, they have adopted the plans submitted to them by M. Chatard, manager of the Continental Edison Company. This project provides for an installation capable of supplying 2,000 lamps, divided into two units each of 1,000 lamps, considering the existing installation of the Capitol as duplicate in case of accident to one of these units.

The position chosen for the electric central station is upon the same site as that of the present gas works, both on account of the saving in the ground now required, or afterwards rendered necessary in case of extensions, and also to avoid any dispute as to noise of the machinery. Moreover, the concentration of the works for the supply of both gas and electric light will permit of considerable economy in maintenance and management. The heat lost in the gas furnaces would be able to provide some 120 h.p., half the power needed for the 2,000 lamps, without cost for fuel. The coke dust, now a useless product, burnt in special fire grates, will become a valuable fuel for boilers of the central electric station. Water for feed and for condensing taken from the neighbouring canal will be far more easily obtainable than if the station had been in the town. Lastly, the general supervision of the two services of gas and electricity, by this concentration, will be greatly simplified and facilitated.

The station being situated about 1½ miles from the business centre of the town and the theatres and *cafés* necessitates the employment of a high-tension current, and the alternate-current system of Zipernowski and Deri has been adopted.

The simplicity of this system gives the great advantage to the gas company of allowing it to run the main cables very economically, not only to the present centres of consumption, but to any other point where the necessity or demand arises for the light, at whatever distance.

The electric station is arranged in such a manner that it can be increased by successive units of 1,000 lamps, as the necessity arises, without altering the general disposition. It only contains for the present one unit of 1,000 lamps. Two semi-tubular boilers are supplied by the Compagnie Lyonnaise. The steam-engine is a triple expansion, Pilon type, 150 h.p. effective, supplied by M. W. Weyher et Richemond. The electric part has been entirely supplied by the Continental Edison Company, the dynamo is of the Zipernowski-Deri type, working at 2,000 volts and 42 amperes. The guaranteed minimum efficiency is 84 per cent. of the motor power. It will be coupled or parallel with the others when the installation is complete.

The high-tension mains have been laid for a supply of 2,500 lamps, and is entirely underground. The cables are covered with three coatings of indiarubber, two layers of indiarubber tape, and two servings of braid are laid in creosoted wood troughing. The diameters of the wires have been calculated so that the loss in the conductors should not exceed 5 per cent., and that the intensity of the current per square millimetre of section should not exceed 0·6 ampere. No heating need therefore be feared.

At the present moment the electric station supplies the Théâtre des Variétés with current for 477 lamps, and six other subscribers with 249 lamps, making a total of 726 lamps. The remaining 274 lamps now at disposal will doubtless be shortly taken up, for the enquiries for supply are very numerous. Toulouse is a pleasure city, where the electric light will be in great repute on account of the advantages in point of comfort and display which follow in its use. The directorate of the gas company and their chairman, M. Brouardel, are to be congratulated on thus being in the van of progress, and not isolating themselves, as too often heretofore the case with the gas companies, in their present monopoly of gas supply.

NEW YORK NOTES.

(FROM OUR SPECIAL CORRESPONDENT.)

Manslaughter by Electricity.—A Curious Indictment.
The Wire-cutters' Force to be Diminished.
Proposed Suit Against the City.
Underground Work in Brooklyn.
Report of the Brooklyn Subway Commission.
Visitors from la belle France.
"Electrocution" Pronounced Constitutional.
The First Central Station in the World Destroyed by Fire.

NEW YORK, *January 3, 1890.*

The indictment brought in by the grand jury at the conclusion of their recent investigation of the overhead wire question was against Mr. C. W. Pierce, the superintendent of lamps of the Brush Company, and the manager of that company is not implicated as I inadvertently stated in my last. The indictment is a very curious document, and, being the first of its kind, is not without interest to electrical readers. The following is a fair sample: "The Grand Jury of the city and county of New York by this indictment accuse Charles W. Pierce of the crime of manslaughter, committed as follows: The said Charles W. Pierce, late of the city of New York, in the county of New York, aforesaid, on the 30th day of November, in the year of our Lord one thousand eight hundred and eighty-nine, at the city and county aforesaid, with force and arms, in and upon the body of one Henry Harris, then and there being, wilfully and feloniously did make an assault, and a current of electricity of great and deadly power and intensity through and into the body of him, the said Henry Harris, then and there wilfully and feloniously did put, place, and pass, and cause and procure to be put and placed and to pass, and the said current of electricity through and into the body of the said Henry Harris, did then and there wilfully and feloniously keep and continue, and cause and procure to be kept and continue for a space of time—to wit, for the space of five seconds—thereby given unto him the said Henry Harris, then and there with the electric current aforesaid, a mortal electric shock, of which said mortal shock he, the said Henry Harris, then and there died. And so the grand jury aforesaid do say that the said Charles W. Pierce him, the said Henry Harris, in the manner aforesaid, and by the means aforesaid, wilfully and feloniously did kill and slay, against the form of the statute in such case made and provided and against the peace of the people of the State of New York and their dignity." Mr. Pierce was admitted to bail, the president of the Brush Company furnishing the necessary bond; no date has yet been fixed for the trial.

According to the latest reports the force of wire destroyers employed by the city is now to be diminished, as the Board of Electrical Control are of the opinion that most of the dangerous wires have been removed. The Commissioner of Public Works does not concur with this opinion, and is anxious to keep on with the work with the full force of 86 men until the job assigned to him by the court is finished. During the month that they have been at work the wire-cutters have taken down about 300 miles of wires, chiefly electric light wire, which was in a dangerous condition or not strung in accordance with the law. It is also said that they have removed a considerable quantity of dead telephone and telegraph wires. Complaints have been pouring into the newspaper offices from tradesmen all over the city of the losses which have been inflicted upon them during the holiday season by the absence of light from streets and shops. As a natural consequence, some of the newspapers now seem to think that the city authorities have been over hasty in their crusade against the overhead wires, although only a short time ago they all united in howling "down with the wires" as the only solution of the difficult problem.

The illuminating companies have been watching the operations of the wire-cutters very closely, noting down their losses with a view to eventually making the city pay up. They state that, so far, over 200 miles of good new wire have been cut down, and they propose to sue the city for the value of that wire, which value they represent to be about 40,000dols. The companies also intend to try and recover damages for the loss of revenue entailed by their inability to supply customers under the present conditions; even where they have wires underground they are unable to use them, as the connections between the generating stations and the subways have been destroyed by the wire-cutting gang. To this the wire-cutters say that the companies, so far, have made little or no effort to use the subways, which in some cases run almost to the premises of the various companies, and that they are only now being driven into the subways by the removal of the overhead wires.

It is a pleasant contrast to the wretched muddle which the blundering policy of the Board of Electrical Control has brought about in New York, to turn to the extensive and scientific and practical report which the Subway Commission of Brooklyn have just presented to the Mayor of that city. The Brooklyn Commission is composed of capable and energetic men of scientific knowledge and experience, and they have, therefore, contrived to carry out their work in harmony with all the interests involved. Their term of office expired on the 31st October last, and they have made an extremely lengthy report to the Mayor, reviewing the whole underground situation in a clear manner, and giving details of the work accomplished in Brooklyn.

The aggregate length of conductors underground has been increased during the 11 months ending October 31st, 1889, about 839 miles. The length of telephone cable attached to the elevated railroad structure during the same period is about seven miles, carrying 644 miles of conductors. The total mileage of wires now underground in Brooklyn (apart from city wires), is 3,007 miles; on the elevated railways (apart from electric light wires), 768 miles. The aggregate thus removed from house-tops and poles is larger than the total of aerial telegraph and telephone wires existing in Brooklyn in 1885, when the Board was organised. During the 11 months, 1·418 miles of additional conduits, having a capacity of 786 miles of conductors, have been constructed. The telephone company has removed 71 poles, making the aggregate number of poles removed (not including those removed this year by the electric light companies, from which no report has been received) 445. And the telephone wires have been removed from 271 poles, which are still standing because they carry city wires. Permits have been granted for the construction of 8·77 miles of additional conduits having a capacity of 3,500 miles of conductor, and the telephone company has applied for permission to build further conduits to the extent of 10·2 miles with a minimum capacity of 4,000 miles of wire. The two electric lighting companies in Brooklyn have between them 341 miles of wire, of which the greater part is overhead, 50 miles only being suspended from the elevated railway structure. More than 230 miles of this wire is of the class known as "underwriters." The Commission point out that owing to the inconsistency of the law they had no authority to control the installations of the electric light companies, or to interfere with their operations in any way! The report describes with minute detail the policy of the Commission throughout, setting out with this remarkable sentence: "In view of the inconsistency, inadequacy, and partial absurdity of the law, the question might be asked how citizens with reputations to lose could consent to administer it?" However, yielding to the representations of the Mayor, they did consent, and, meeting with the hearty co-operation of the telephone company, the three commissioners have acquitted themselves remarkably well.

The principal telephone companies of the United States are now receiving visits from two French engineers who are making a tour of inspection in search of useful information. These gentlemen, MM. G. de la Touanne and G. Séligmann-Lui, are both telegraph engineers belonging to the technical staff of the French Government telegraph department, and will have to do with the reorganisation of the telephone system. They have spent a week in New York inspecting the exchanges of the Metropolitan Telephone Company, the Brooklyn Company, and the headquarters of the Long Distance Company, priming themselves thoroughly with all the profitable knowledge of telephone matters which American telephone engineers are capable of imparting. MM. de la Touanne and Séligmann-Lui will visit Boston, Montreal, Chicago, and various other towns, returning to New York at the end of this month.

The general term of the Supreme Court has rendered its decision in the Kemmler case, dismissing the writ of *habeas corpus* which was taken out by the prisoner's counsel on the ground that execution by electricity would be unconstitutional, because that mode of punishment would be "cruel and unusual." The judge suggested that it could safely be presumed that the Legislature had sufficiently investigated the nature of punishment before passing the law, and reviews the work of the committee which investigated methods of capital punishment. After reviewing the experiments made upon animals and the accidental deaths of recent occurrence, the judge concludes: "The light of the scientific evidence in this case is sufficient, as we think, to remove every reasonable doubt that the passage of a current of electricity of a certain well-determined intensity through the vital parts of the body under chosen conditions of contact and resistance, must result in instantaneous death. If the question were of the advisability in the change of the mode of inflicting death by capital punishment the discussion might be prolonged. As we are confined to a question of constitutionality, we deem further discussion unnecessary. The order dismissing the point of *habeas corpus* and remanding the prisoner must be affirmed." Kemmler's counsel will carry the case to the Court of Appeals, and a final decision will not be reached until February at the earliest, probably a good deal later. The fate of two other murderers now under sentence in New York hangs on the decision in the Kemmler case.

Yesterday morning the Edison central station at Pearl-street, the first central station in New York—and, it is said, in the world—was completely destroyed by fire. The fire occurred early in the morning, and broke out in the dynamo-room, spreading so rapidly that the entire fire brigade force of the down-town district had all they could do to prevent the flames spreading to the adjoining buildings. The station supplied about 18,000 lights in the business district, most of which are kept burning all day, and naturally the loss of the light caused much inconvenience. By evening, however, everything was running smoothly again as current was turned on from the Liberty-street station close by, the two stations being connected by underground mains, which were not damaged by the fire. The loss on the machinery, etc., is estimated at 100,000dols., of which about one-half is covered by insurance.

Old Students' Association.—A special general meeting of the City and Guilds of London Institute Old Students' Association will be held on Wednesday, Jan. 29, 1890, at 8 p.m., at the Central Institution, Exhibition-road, S.W., for the consideration of certain changes in the rules of the association, which the committee will propose. The report of the association for the session 1888-89 shows a favourable financial position, the subscriptions being larger, and donations having been received from the Clothworkers' Company. The report also shows a satisfactory progress in members, now numbering 194 persons.

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We may occasionally follow the lead of our American Contemporaries, especially when they point out a serviceable way. They are not backward in asking their friends to do all they can for the welfare of the paper. We ask our friends to remember us. No paper that we know ever refuses Subscribers or Advertisers. Nor do we; in fact, we invite them, believing that they will get full value for their money.

Specimen copies of the paper will be sent on request.

A CHALLENGE.

We have long known that some of the tramway managers were desirous of utilising electrical traction upon their lines, if they could be convinced that such traction would not fail them at a pinch, and would not be excessive as regards cost. Electrical engineers, ourselves among the number, have endeavoured to awaken the public interest, and inform those who ought to know as to the value of electricity in replacing horseflesh. We have said that even in these days of cheap fodder, electricity could compete favourably in price with the present system. Now a tramway company has taken up the challenge, and, as will be seen from our advertisement columns, the Lea Bridge, Leyton, and Walthamstow Tram Co., in view of having to get fresh tenders for horsing its cars, is prepared to enter into a contract with any electrical engineering company of repute to instal electric traction upon its lines. No doubt this step has been taken because of what a correspondent calls "a very florid notice in one of the daily papers." If anyone desires to read this "very florid notice," let him read the *Daily News* article, Jan. 9, and, among other information there given, it will be found that the average cost of horse traction over the North Metropolitan Company's system may be taken at 6½d. per mile. The "notice" also says that "taking the whole of London, there are much higher averages than that." This statement is somewhat vague, and may be taken for what it is worth.

Taking the average cost of horse traction at 6½d. per mile, and the mileage of the Lea Bridge Company at 300,000 miles, if the company would pay that rate for electric traction it means an income of £8,125. If, however, only 6d. a mile was paid the sum would be £7,500. We have been informed at various times and by various tramway authorities that the cost of horse traction is even less than this; if that be not so, the better for electric traction. At any rate, there is the offer, and if the terms are anything like those we have mentioned, it ought not to take long for half-a-dozen firms to make up their minds whether the contract would be worth having. It seems to us, however, that in such a case as the one under consideration the system is almost restricted to a self-contained one—that is, by means of accumulators—and, as most of our readers know, we have always rather favoured a different system. To instal another system would mean underground conductors, would mean a serious initial expense, and no firm would think of this for a contract to last only two or three years. It is not many weeks since we chronicled the arrival of a special representative of the Thomson-Houston system, and from the energy these people have displayed in the States it may safely be imagined that, at any rate, this offer will be investigated. Then the Electric Construction Company has the control of the Electrical Power Storage and of the Julien batteries, of the Sprague motors and of the Elwell-Parker motors, so that an opportunity of entering upon tram work should not be lost. Other companies have done and are doing yeoman's service; thus we trust the challenge will be taken up, and that speedily. If the figures given by the various traction companies and syndicates are to be taken as approximately accurate, and the payments of the Lea Company approach those mentioned above, there is no doubt a contract over a number of years would be a profitable transaction. Or if some arrangement concerning the initial expense could be made, a contract over two or three years ought not to be despised.

There is one point in connection with tramway work which companies intending to take up electric traction must not forget. The field is immense, and undoubtedly that firm or company which brings off a successful installation upon a fairly large scale will be inundated with orders. There never can be a better time than the present for taking a front rank in this branch of the industry. There is far more opportunity of making money in it than there is in purely electric light work. Who will take up the challenge?

CARDIFF: A TALE OF ANCIENT DAYS.

"And it came to pass," said the historian, "that in the reign of Victoria men ran to and fro over the face of the earth, and knowledge increased; but like the fruits of the earth, which are bountifully given in favoured places, knowledge in the glorious reign referred to increased only locally. In those days information was disseminated by means of newspapers and books, as well as by the voice of the teacher. Frequently, however, those who read, or pretended to read, the sources of information, read them in so desultory a way that their contents made no impression. At the time of which we are speaking, business was largely transacted by many men contributing a portion of the capital required, and in the game of speculation men of a grasping nature always took care, as the writers of that time put it, to have something in the new venture. As a rule, men of this class mostly lost their money, but occasionally the venture proved astonishingly successful, and huge fortunes were made by the favoured few. Hence the almost universal desire to try and be one of those few. During the last quarter of the century a new departure was taken in regard to artificial light. After an exposition of the new light in the then gay city of Paris, which my hearers may know was the capital of a country which went by the name of France, men hastened to invest of their savings in this artificial light. They regarded not its defects, and so in after years, when great improvements had been made, and the light was more valuable than any other artificial light, the men who had plunged and lost were continually attempting to hinder the spread of the light. They maintained as it was it remained, its defects were not removed and were not removable, and yet at the same time, in numbers of places within a few hours' journey, it was possible to actually see the light as these ignorant men said it was not. Gentlemen, can anything be more convincing than that with the boasted civilisation of the nineteenth century, with all their methods of intercommunication, knowledge was but locally distributed. Speaking as I do, at the last decade of the twentieth century, I cannot do better, to show how swift and how far has been the advance during the past hundred years, than say, what you all know, that it would be impossible for any public speaker to obtain credence with his hearers if the information he propounded was but a ten short years out of date. Let me cite one example, and one only, of how public men in those days remained ignorant of what took place all around them. There was a large and prosperous town, in the southern portion of the appanage of Great Britain called Wales, into which public-spirited companies, desirous of adding to the wealth in their coffers, desired to introduce the electric light. This was in the year 1890. A worthy citizen of that town, known as 'Councillor Carr,' was one of the scribes whose ambition was to enlighten his fellow-men, and for this purpose he wrote lengthy articles to a newspaper called the *Evening Express*. You know that my collection of the literature of that period is various and extensive, and I happen to possess a copy of that paper dated January 13, 1890, in which occurs the following sentences:

"'But for street lighting and for what may be called all ordinary purposes it is not in the nature of things that the electric light can or ever will compete, either as regards price or practical usefulness, with gas.

"'The arc light might possibly be useful for street illumination if it could be properly distributed—if instead of one light of 2,000 power we could have ten lights of 200 candle-power each. *But in the present state of electrical science this is impossible.* As regards the incandescent light for street purposes its application, so as to obtain as much effective light as the gas company supplies at present, would cost the town three times as much as we are paying at the present time.'

"I have laid stress upon Councillor Carr's statement as to 'impossibility' at that particular time, because it proves my contention up to the hilt that in those days men were allowed to publish matter which showed them to be utterly ignorant of the subject about which they pretended to teach. Since the law was passed to make such wilful or ignorant errors a criminal offence, you are aware how careful public teachers are to avoid giving cause for legal procedure. Now, I tell you as a matter of history, nay, as a matter of fact, that the greater part of my quotation is simply a tissue of falsehoods. At that time, January 13, 1890, the electric light did compete, and competed successfully both as regards price and practical usefulness, with the other illuminant he mentions—namely, gas.

"I have to tell you also that, so far as the arc light was concerned, it was both possible and practical to give arc lights of 200 candle-power each. The misfortune with our ancestors was that far too often these ignorant teachers were believed, to the detriment to the well-being of the public. It was not till half a century after that the agitation to repress ignorant teachers was successful, and undoubtedly it is due to such repression that the recent progress has been so great. I am thankful to say that Cardiff did not agree with the statement of its councillor, but was one among those few towns whose actions were governed by a far-sighted wisdom. Its Council decided that the light was an advance, they decided to support its introduction, their views were expressed in terse and vigorous language, 'that more light was wanted, and more light they would have.' Under the enlightened regime the prosperity of the town increased, and now, a century after the time mentioned, it ranks as one of the wealthiest, and prosperous, and best-known cities of this great empire."—*From the inaugural speech of the Public Prosecutor of Ignorance for Cardiff, as reported in the Cardiff "Non mi Recordo" of January 14, 1990.*

INSTITUTION OF ELECTRICAL ENGINEERS.

INAUGURAL ADDRESS BY J. HOPKINSON, M.A., D.Sc., F.R.S., PRESIDENT, ON "MAGNETISM."

(Concluded from page 29.)

No single body is known having the property of capacity for magnetism in a degree which is neither very great nor very small, but intermediate between the two extremes. We can, however, mix magnetic and non-magnetic substances to form bodies apparently intermediate. It is, therefore, interesting to consider what the properties might be of such a mixture. It depends quite as much on the way in which the magnetic part is arranged in the mass, as on its actual quantity. Suppose, for example, it is arranged as in Fig. 4, in threads or plates having a very long axis in the direction of the magnetising force, we may at once determine the curve of magnetisation of the mixture from that of the magnetic substance by dividing the induction for any given force in the ratio of the whole volume to the volume of magnetic substance. If, on the other hand, it is as in Fig. 5—with a very short axis in the direction of the force, and a long axis perpendicular thereto—we can equally construct the curve of magnetisation. This is done in Fig. 6, which shows the curve when nine-tenths of the material is highly magnetic iron arranged as in Fig. 5, whilst the other curve of the same figure is that when only one-tenth is magnetic, but arranged as in Fig. 4. You observe how very different is the character of the curve—a difference which is reduced by the much less proportion of magnetic material in the mixture in the one case than in the other. One peculiarity of these arrangements of the two materials in relation to each other is, that the resulting material is not isotropic; that is, its properties are not the same in all directions, but depend upon the direction of the magnetising force in the material. Of course, this is not at all a probable arrangement, but it is instructive in showing the character of the result as depending upon the construction of the material. Let us, however, consider the simplest isotropic arrangement. Let us suppose that one material is in the form of spheres bedded in a matrix of the other. If the spheres are placed at random this is clearly an isotropic arrangement. The result is very different according as the matrix or the spheres are of the magnetic material. Suppose that the volume of the spheres is one-half of the whole volume. In Fig. 7 we have approximately the curve for iron, for a mixture of equal quantities of iron and a non-magnetic material, the spheres being non-magnetic

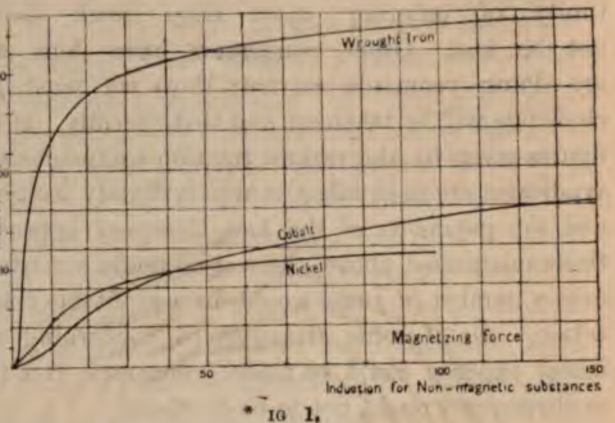

*Fig. 1.

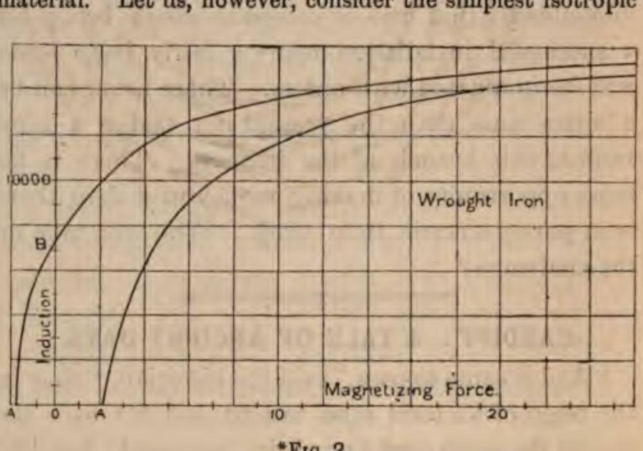

*Fig. 2.

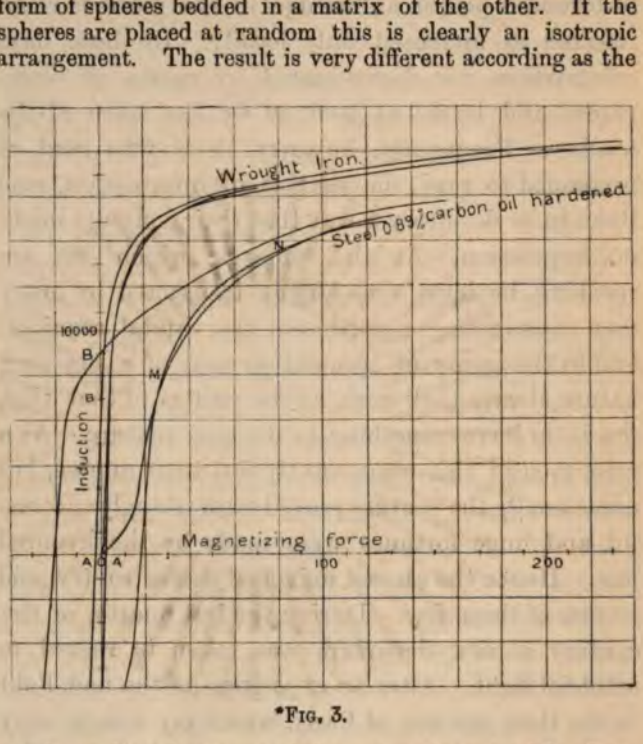

*Fig. 3.

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* For description of Figs. 1, 2, and 3, see our last issue.

and the matrix iron, and for a mixture the spheres being iron and the matrix non-magnetic. Observe the great difference. When the spheres are iron the induction is near four times the force for all values of the force. When the matrix is iron, the induction is near two-fifths of the induction when the material is iron only.

In speaking of the properties of bodies which, like manganese steel, are slightly magnetic, it may be well here to enter a caution. But little that is instructive is to be learned by testing filings, or the like, with magnets, as these show but little difference between bodies which are slightly magnetic and those which are strongly magnetic.

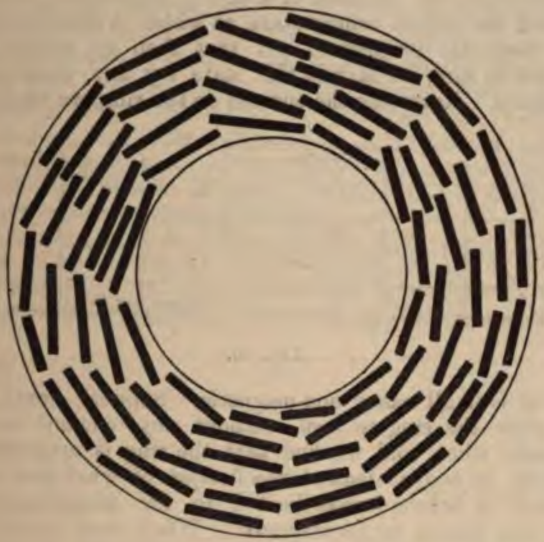

FIG. 4.

Suppose the filings to be spheres, in the following table are given comparative values of the forces they would experience in terms of μ, if placed in a magnetic field of given value, μ having its ordinary signification—that is, being the ratio of the kick on the galvanometer when a ring is tried made of the material of the filing to the kick if the ring is made of a perfectly non-magnetic material:

μ.	Attraction.	
1	0	Non-magnetic body.
1·47	0·18	Manganese steel with 12 per cent.
3·6	1·2	Manganese steel with 9 per cent.
5	1·5	
10	2·1	
100	2·8	
1,000	2·98	

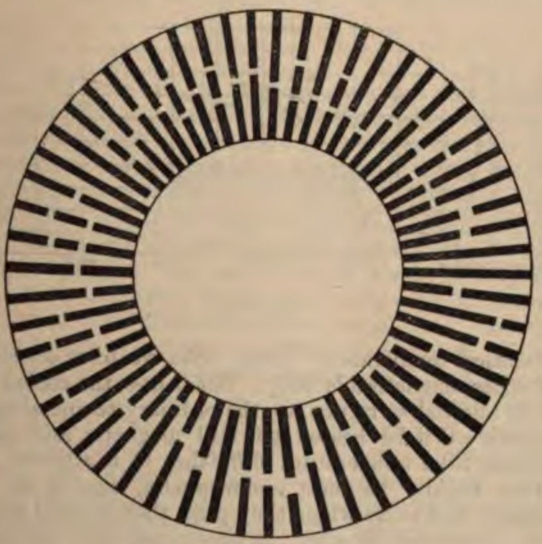

FIG. 5.

Now bodies in which μ is so small as 3·6 belong distinctly to the non-magnetic class; but the test with the magnet would very markedly distinguish them from manganese steel with 12 per cent. of manganese. The distinction, however, between $\mu = 3·6$ and $\mu = 1{,}000$ is comparatively small; whereas, under the conditions of experiment, μ is much more than 1,000 for most bodies of which iron is the principal constituent.

The effect of stress on the magnetic properties of iron and nickel have been studied by Sir. W. Thomson. A fact interesting from a broad and general point of view is that the effects of stress are different in kind in the case of iron and nickel. In the case of iron, for small magnetising forces in the direction of the tension, tension increases the magnetisation; for large forces, diminishes it. In the case of nickel the effect is always to diminish the magnetisation.

When one considers that the magnetic property is peculiar to three substances, that it is easily destroyed by the admixture of some foreign body, as manganese, one would naturally expect that its existence would depend also on the temperature of the body. This is found to be the case.

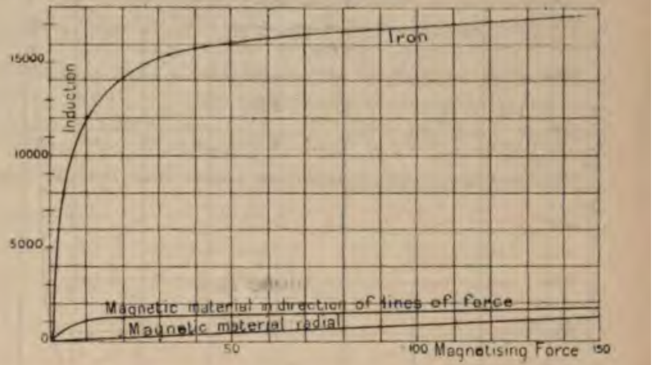

FIG. 6.

It has long been known that iron remains magnetic to a red heat, and that then it somewhat suddenly ceases to be magnetic, and remains at a higher temperature non-magnetic. It has long been known that the same thing happens with cobalt, the temperature of change, however, being higher; and with nickel, the temperature being lower. The magnetic characteristics of iron at a high temperature are interesting. Let us return to our ring, and let us suppose that the coils are insulated with a refractory material, such as asbestos paper, and that the ring is made of the best soft iron. We are now in a position to heat the ring to a high temperature, and to experiment upon it at high temperatures in exactly the same way as before. The temperature can be approximately determined by the resistance of one of the copper coils. Suppose, first, that the current in the primary circuit which we use for magnetising the ring is small; that from time to time, as the ring is heated and the temperature rises, an experiment is made by reversing the current in the primary circuit and observing the deflection of the galvanometer needle. At the ordinary temperature of the air the deflection is comparatively small; as the temperature increases the deflection also increases, but slowly at first; when the temperature, however, reaches something like 600deg. C., the galvanometer deflection begins very rapidly to increase, until, with a temperature of 770deg. C., it attains a value of no less than 11,000 times as great as the deflection would be if the ring had been made of glass or copper, and the same exciting current had been used. Of course a direct comparison of 11,000

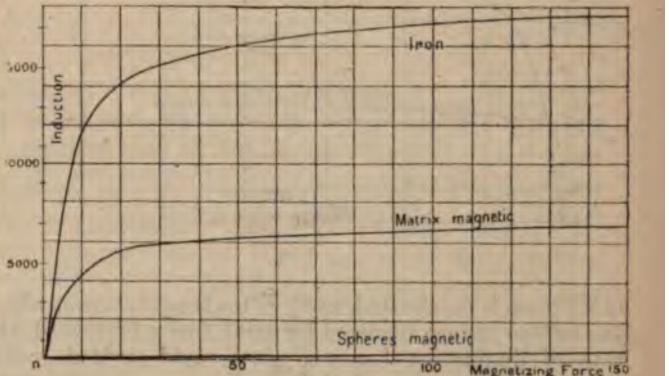

FIG. 7.

to 1 cannot be made: to make it we must introduce resistance into the secondary circuit when the iron is used; and we must, in fact, make use of larger currents when copper is used. However, the ratio of the induction in the case of iron to that in the case of copper, at 770deg. C., for small forces is no less than 11,000 to 1. Now mark what happens. The temperature rises another 15deg. C.; the deflection of the needle suddenly drops to a value which we must regard as infinitesimal in comparison to that which it had at a temperature of 770deg. C.; in fact, at the higher temperature of 785deg. C. the deflection of the galvanometer with iron is to that with copper in a ratio not exceeding that of 1·14 to 1. Here, then, we have a most remarkable fact: at a temperature of 770deg. C. the magnetisation of iron 11,000 times as great as that of a non-magnetic substance; at a temperature of 785deg. C. iron practically non-magnetic. These changes are shown in Fig. 8. Suppose, now, that the current in the primary circuit which serves to magnetise the iron had been great instead of very small. In this case we find a very different order of phenomena. As the temperature rises, the deflection on the galvanometer diminishes very slowly till a high temperature is attained. Then the rate of decrease is accelerated until, as the temperature at which the sudden change occurred for small forces is reached, the rate of diminution becomes very rapid indeed, until, finally, the magnetism of the iron disappears at the same time as for small forces. Instead of following the magnetisation with constant forces for varying temperatures, we may trace the curve of magnetisation for varying forces with any temperature we please. Such curves are given in Diagrams 9 and 10. In the one diagram, for the purpose of bringing out different points in the curve, the scale of abscissæ is 20 times as great as in the other. You will observe that the effect of rise of temperature is to diminish the maximum magnetisation of which the body is capable, slowly at first, and rapidly at the end. It is also very greatly to diminish the coercive force, and to increase the facility with which the body is magnetised. To give an idea of the magnetising forces in question, the force for Fig. 8 was 0·3; and as you see from Figs. 9 and 10, the force ranges as high as 60. Now the earth's force in these latitudes is 0·43, and the horizontal component of the earth's force is 0·18. In the field of a dynamo machine the force is often more than 7,000. In addition to the general characteristics of the curve of magnetisation, a very interesting, and, as I take it, a very important, fact comes out. I have already stated that if the ring be submitted to a great current in one direction, which current is afterwards gradually reduced to zero, the ring is not in its non-magnetic condition, but that it is, in fact, strongly magnetised. Suppose now we heat the ring, whilst under the influence of a strong magnetising current, beyond the critical temperature at which it ceases to have any magnetic properties, and that then we reduce the current to zero, we may in this state try any experiment we please. Reversing the current on the ring, we shall find that it is in all cases non-magnetic. Suppose next that we allow the ring to cool without any current in the primary, when cold we find that the ring is magnetised; in fact, it has a distinct recollection of what had been done to it before it was heated to the temperature at which it ceased to be magnetic. When steel is tried in the same way with varying temperatures, a similar sequence of phenomena is observed; but for small forces the permeability rises to a lower maximum, and its rise is less rapid. The critical temperature at which magnetism disappears changes rapidly with the composition of the steel. For very soft charcoal iron wire the critical temperature is as high as 880deg. C.; for hard Whitworth steel it is 690deg. C.

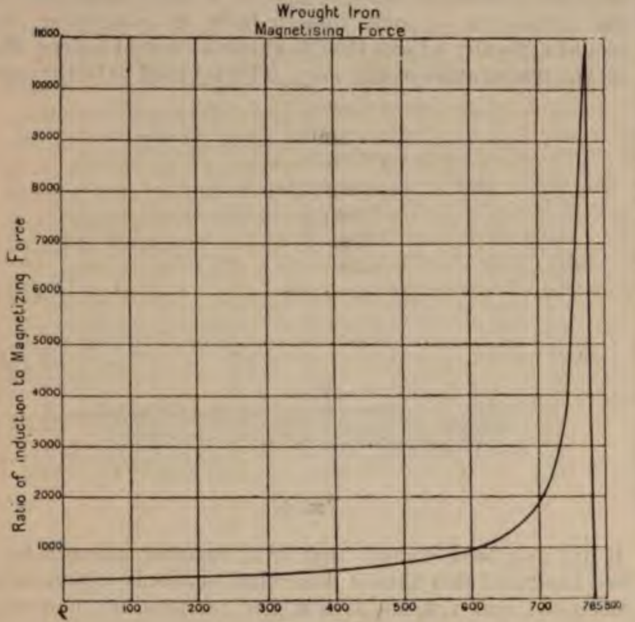

Fig. 8.

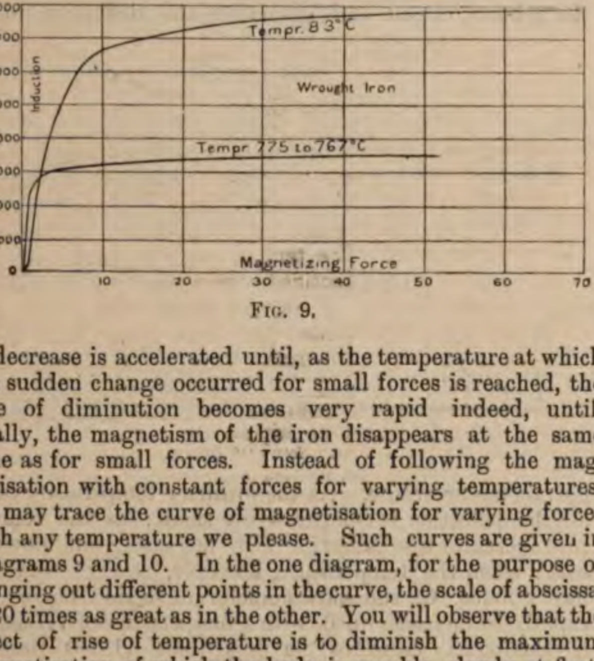

Fig. 9.

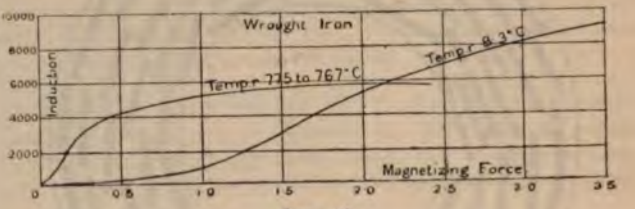

Fig. 10.

The properties of an alloy of manganese and iron are curious. More curious are those of an alloy of nickel and iron. The alloy of nickel and iron containing 25 per cent. of nickel is non-magnetic as it is sure to come from the manufacturer; that is to say, a substance compounded of two magnetic bodies is non-magnetic. Cool it, however, a little below freezing, and its properties change; it becomes very decidedly magnetic. This is perhaps not so very remarkable: the nickel steel has a low critical temperature—lower than we have observed in any other magnetisable body. But if now the cooled material be allowed to return to the ordinary temperature it is magnetic; if it be heated it is still magnetic, and remains magnetic till a temperature of 580deg. C. is attained, when it very rapidly becomes non-magnetic, exactly as other magnetic bodies do when they pass their critical temperature. Now cool the alloy: it is non-magnetic, and remains non-magnetic till the temperature has fallen to below freezing. The history of the material is shown in Fig. 11, from which it will be seen that from – 20deg. C. to 580deg. C. this alloy may exist in either of two states, both quite stable—a magnetic and a non-magnetic—and that the state is determined by whether the alloy has been last cooled to – 20deg. C. or heated to 580deg. C.

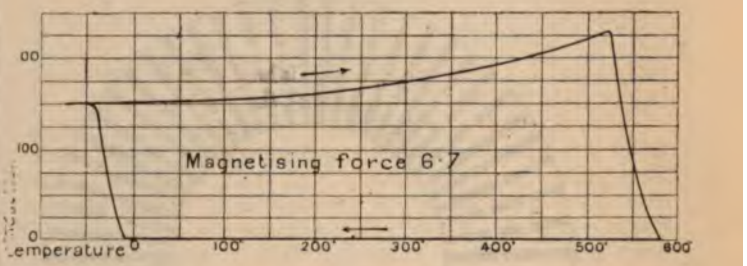

Fig. 11.

Sudden changes occur in other properties of iron at this very critical temperature at which its magnetism disappears. For example, take its electrical resistance. On the curve, Fig. 12, is shown the electrical resistance of iron at various temperatures; and also, in blue, the electrical resistance of copper or other pure metal. Observe the difference. If the iron is heated, its resistance increases with an accelerating velocity, until, when near the critical temperature, the rate of increase is five times as much as the copper; at the critical temperature the rate suddenly changes, and it assumes a value which, as far as experiments have gone, cannot be said to differ very materially from a pure metal. The resistance of manganese steel shows no such change. Its temperature coefficient constantly has the value of ·0012, which it has at the ordinary temperature of the air. The electrical resistance of nickel varies with temperature in an exactly similar manner. Again, Prof. Tait has shown that the thermo-electric properties of iron are very anomalous, that there is a sudden change at or about the temperature at which the metal becomes non-magnetic, and that before this temperature is reached the variations of thermo-electric property are quite different from a non-magnetic metal.

Prof. Tomlinson has investigated how many other properties of iron depend upon the temperature. But the most significant phenomenon is that indicated by the property of recalescence. Prof. Barrett, of Dublin, observed that if a wire of hard steel is heated to a very bright redness, and is then allowed to cool, the wire will cool down till it hardly emits any light at all, and that then it suddenly glows out quite bright again, and afterwards finally cools. This phenomenon is observed with great difficulty in the case of soft iron, and is not observed at all in the case of manganese steel. A fairly approximate numerical measurement may be made in this way: Take a block of iron or steel on which a groove is cut, and in this groove wind a coil of copper wire insulated with asbestos; cover the coil with many layers of asbestos; and finally cover the whole lump of iron or steel with asbestos again. We have now a body which will heat and cool comparatively slowly, and which will lose its heat at a rate very approximately proportional to the difference of temperature between it and the surrounding air. Heat the block to a bright redness, and take it out of the fire and observe the resistance of the copper coil as the temperature falls, due to the cooling of the block. Plot a curve in which the abscissæ are the times, and the ordinates the logarithms, of the increase of resistance of the copper coil above its resistance at the temperature of the room. If the specific heat of the iron were constant, this curve would be a straight line; if at any particular temperature latent heat were liberated, the curve would be horizontal so long as the heat was being liberated. If, now, a block be made of manganese steel, it is found that the curve is very nearly a straight line, showing that there is no liberation of latent heat at any temperature. If it is made of nickel steel with 25 per cent. of nickel, in its non-magnetic state, the result is the same—no sign of liberation of heat. If, now, the block be made of hard steel, the temperature diminishes at first; then the curve (Fig. 13) which represents the temperature bends round; the temperature actually rises many degrees whilst the body is losing heat. The liberation of heat being completed, the curve finally descends as a straight line. From inspection of this curve it is apparent why hard steel exhibits a sudden accession of brightness as it yields up its heat. In the case of soft iron the temperature does not actually rise as the body loses heat, but the curve remains horizontal, or nearly horizontal, for a considerable time. This, again, shows why, although a considerable amount of heat is liberated at a temperature corresponding to the horizontal part of the curve, no marked recalescence can be obtained. From curves such as these it is easy to calculate the amount of heat which becomes latent. As the iron passes the critical point it is found to be about 200 times as much heat as is required to raise the temperature of the iron 1deg. C. From this we get a very good idea of the importance of the phenomenon. When ice is melted and becomes water, the heat absorbed is 80 times the heat required to raise the temperature of the water 1deg. C., and 160 times the heat required to raise the temperature of the ice by the same amount. The temperature of recalescence has been abundantly identified with the critical temperature of magnetism.* I am not aware that anything corresponding with recalescence has been observed in the case of nickel. Experiments have been tried, and gave a

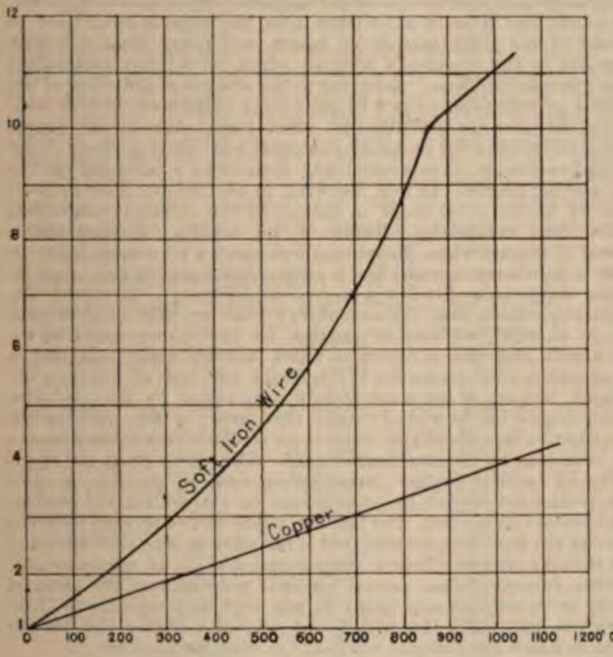

FIG. 12.

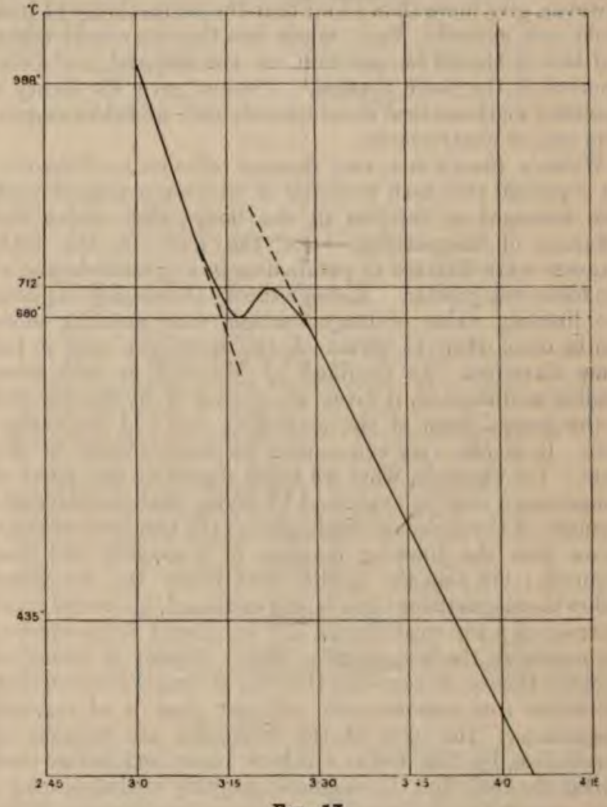

FIG. 13.

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* I have only recently become acquainted with the admirable work of M. Osmond on recalescence. He has examined a great variety of samples of steel, and determined the temperatures at which they give off an exceptional amount of heat. Some of his results are apparent on my own curves, though I had assumed them to be mere errors of observation. For example, referring to my Royal Society paper, there is, in Fig. 38, a hint of a second small anomalous point a little below the larger one. And, comparing Figs. 38 and 38A, we see that the higher the heating the lower is the point of recalescence; both features are brought out by M. Osmond. The double recalescence observed by M. Osmond in steel with a moderate quantity of carbon I would explain provisionally by supposing this steel to be a mixture of two kinds which have different critical temperatures. Although M. Osmond's method is admirable for determining the temperature of recalescence, and whether it is a single point or multiple, it is not adapted to determine the quantity of heat liberated, as the small sample used is enclosed in a tube of considerable mass, which cools down at the same time as the sample experimented upon.

negative result, but the sample was impure; and the result may, I think, be distrusted as an indication of what it would be in the case of pure nickel. The most probable explanation in the case of iron, at all events, appears to be that when iron passes from the magnetic to the non-magnetic state it experiences a change of state of comparable importance with the change from the solid to the liquid state, and that a large quantity of heat is absorbed in the change. There is, then, no need to suppose chemical change; the great physical fact accompanying the absorption of heat is the disappearance of the capacity for magnetisation.

What explanations have been offered of the phenomena of magnetism? That the explanation must be molecular was early apparent. Poisson's hypothesis was that each molecule of a magnet contained two magnetic fluids, which were separated from each other under the influence of magnetic force. His theory explained the fact of magnetism induced by proximity to magnets, but beyond this it could not go. It gave no hint that there was a limit to the magnetisation of iron, a point of saturation, none of hysteresis, no hint of any connection between the magnetism of iron and any other property of the substance, no hint why magnetism disappears at a high temperature. It does, however, give more than a hint that the permeability of iron could not exceed a limit much less than its actual value, and that it should be constant for the material, and independent of the force applied. Poisson gave his theory a beautiful mathematical development, still useful in magnetism and in electrostatics.

Weber's theory is a very distinct advance on Poisson's. He supposed that each molecule of iron was a magnet with axes arranged at random in the body; that under the influence of magnetising force the axes of the little magnets were directed to parallelism in a greater degree as the force was greater. Weber's theory thoroughly explains the limiting value of magnetisation, since nothing more can be done than to direct all the molecular axes in the same direction. As modified by Maxwell, or with some similar modification, it gives an account of hysteresis, and of the general form of the ascending curve of magnetisation. It is also very convenient for stating some of the facts. For example, what we know regarding the effect of temperature may be expressed by saying that the magnetic moment of the molecule diminishes as the temperature rises, hence that the limiting moment of a magnet will also diminish; but that the facility with which the molecules follow the magnetising force is also increased, hence the great increase of μ for small forces, and its almost instantaneous extinction as the temperature rises. Again, in terms of Weber's theory, we can state that rise of temperature enough to render iron non-magnetic will not clear it of residual magnetism. The axes of the molecules are brought to parallelism by the force which is impressed before and during the time that the magnetic property is disappearing; they remain parallel when the force ceases, though, being now non-magnetic, their effect is nil. When, the temperature falling, they become again magnetic, the effect of the direction of their axes is apparent. But Weber's theory does not touch the root of the matter by connecting the magnetic property with any other property of iron, nor does it give any hint as to why the moment of the molecule disappears so rapidly at a certain temperature.

Ampère's theory may be said to be a development of Weber's: it purports to state in what the magnetism of the molecule consists. Associated with each molecule is a closed electric current in a circuit of no resistance; each such molecule, with its current, constitutes Weber's magnetic molecule, and all that it can do they can do. But the great merit of the theory—and a very great one it is—is that it brings magnetism in as a branch of electricity; it explains why a current makes a magnetisable body magnetic. It also gives, as extended by Weber, an explanation of diamagnetism. It, however, gives no hint of connecting the magnetic properties of iron with any other property. Another difficulty is this: When iron ceases to be magnetisable, we must assume that the molecular currents cease. These currents represent energy. We should therefore expect that, when iron ceased to be magnetic by rise of temperature, heat would be liberated; the reverse is the fact.

So far as I know, nothing that has ever been proposed even attempts to explain the fundamental anomaly, Why do iron, nickel, and cobalt possess a property which we have found nowhere else in nature? It may be that at lower temperatures other metals would be magnetic, but of this we have at present no indication. It may be that, as has been found to be the case with the permanent gases, we only require a greater degree of cold to extend the rule to cover the exception. For the present, the magnetic properties of iron, nickel, and cobalt stand as exceptional as a breach of that continuity which we are in the habit of regarding as a well-proved law of nature.

AUTHORISED ABSTRACT OF DISCUSSION.

Sir William Thomson said the president had done well to emphasise the marvellous properties of iron, nickel, and cobalt, but he thought these properties were not quite so much isolated as would appear from the address. Faraday showed the continuity between paramagnetic and diamagnetic bodies, and that all substances are susceptible to magnetism when subjected to sufficiently intense magnetising forces. He had also compared the relative susceptibilities of materials such as glass, bismuth, wood, etc., but the absolute determination of their susceptibilities still presents a large field for interesting and valuable research. The fact that the magnetic properties of such substances could be compared was itself of immense importance, whilst Tyndall's observations on the properties of bread, Iceland spar, etc., which can be made, or are naturally, magnetically aniostropic, further enhances the interest connected with the subject. The prodigious difference between the magnetic properties of iron, nickel, and cobalt, and those of other substances, the speaker considered to be one of the great marvels of nature, and many ideas had been suggested by the president's address, which so forcibly emphasised these great distinctions. Referring to the absence of deflection of the ballistic galvanometer when a copper core is withdrawn from a coil, he said this does not prove that no effect takes place in the copper during the process, for in reality two equal and opposite effects occur in rapid succession, thus neutralising each other's influence on the slow-moving needle. In iron, however, in addition to these induced currents in the metal itself, a change in the induced magnetism makes itself evident by a throw of the needle. The fact that a current or magnet when placed near iron exerts a permanent influence on the iron, whereas no such effect is produced on copper or non-magnetic bodies, always seemed to him a marvellous difference. As regards the president's remark that Poisson's theory gave no hint of hysteresis, this, he thought, was open to question, for the theory refers to coercive force, and this is hysteresis under another name. Coming to the subject of recalescence Sir William said this was of immense importance, and one of the wonders duly accentuated by the president. In this connection he wished to add that most of the work on the latent heat of iron about the temperature at which recalescence occurs, had been done by the president himself. The region about the ripple in Fig. 13 requires further investigation, and, if, possible, a cycle such as Andrews used in his experiments on evaporation and condensation should be devised. The material exists in two or more different states at the same temperature, and if the effect is reversible then the iron should cool whilst heat is being supplied to it. In conclusion, Sir William suggested that several physical properties of the material should be tested statically whilst it was kept at temperatures little above and little below the critical one, and also during the various states in which the material exists at the same temperature.

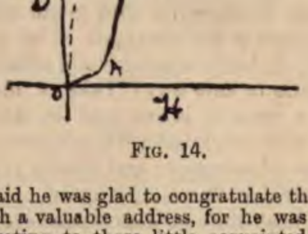

FIG. 14.

Prof. Ewing said he was glad to congratulate the society on being favoured with such a valuable address, for he was sure that it had been no less interesting to those little acquainted with the subject than to those familiar with recent researches. He himself was particularly interested in the matter, and was surprised that all the facts relating to magnetisation had been so clearly stated without using the word "susceptibility," or the expression "intensity of magnetisation." Commenting on the enormous amount of hysteresis exhibited by the alloy of nickel and iron (Fig. 11), Prof. Ewing said he had looked for hysteresis in similar alloys and had found none; now he saw why he found none, for his experiments were made between ordinary atmospheric temperatures and 212deg. F., whilst Dr. Hopkinson, by increasing the range of temperature, had passed the critical points and shown the hysteresis to be very great. One other point he wished to mention in connection with a probable instability which exists when iron is subjected to small magnetising forces. Take the ordinary curve of magnetisation, this may be divided into three portions, O A, A B, B C (see Fig. 14). The part O A had been shown by Lord Rayleigh to be a straight line, and he (the speaker) found that in a true magnetisation curve, where the condition of endlessness was perfectly satisfied, the part A B should be vertical or nearly so. His own experiments were made on rods from 300 to 400 diameters long, and on treating these mathematically as ellipsoids, he found that the magnetising force, H, should be measured from a line, O D, which is practically parallel to A B. A similar result had quite recently been obtained by Mr. Nagaroka, who, in some experiments on the magnetisation of nickel when subjected to mechanical stresses, had succeeded in lengthening the part O A considerably, and then found A B to be practically vertical. In his own (Prof. Ewing's) experiments on iron he found that by tapping a rod whilst subjected to magnetising force a permeability of 20,000 could be obtained.

The discussion was adjourned until the 23rd inst.

TRANSFORMERS.*

BY HARRIS J. RYAN.

(Continued from page 38.)

SECONDARY CLOSED THROUGH ONE LAMP.—(*See* FIG. 6.)

Brush reading.	Primary E.M.F.	Current.	Secondary E.M.F.
28	605	·225	31·4
27	330	·125	15·3
26	917	·048	45·2
25	1,300	·179	67·6
24	1,403	·215	71·7
23	1,300	·235	67·1
22	820	·239	43 8
21	132	·185	4·7
20	835	·000	3·9
19	1,238	·151	61·5
18	1,420	·215	71·7
17	1,363	·238	68·4
16	1,026	·246	52·7
15	170	·215	9·7
14	793	·048	35·6
Observed $\sqrt{\text{mean}^2}$	1,053	·196	52·3
Calculated from curves $\sqrt{\text{mean}^2}$	1,021	·190	51·4

Mean of ammeter readings, 1·26.

SECONDARY CLOSED THROUGH FIVE LAMPS.—(*See* FIG. 7.)

Brush readings.	Primary E.M.F.	Current.	Secondary E.M.F.
29	956	·449	40·3
28	41	·250	10·4
27	723	·000	28·9
26	1,194	·356	54·8
25	1,447	·495	69·1
24	1,350	·483	67·2
23	1,103	·453	57·6
22	293	·304	21·5
21	560	·000	19·8
20	1,110	·318	48·8
19	1,383	·464	65·7
18	1,429	·511	70·0
17	1,228	·500	60·3
16	567	·374	24·0
14·7	585	·030	23·4
Observed $\sqrt{\text{mean}^2}$	1,050	·390	51·0
Calculated from curves $\sqrt{\text{mean}^2}$	1,036	·383	50·6

Mean ammeter reading, 5·83

SECONDARY CLOSED THROUGH TEN LAMPS.—(*See* FIG. 8.)

Brush reading.	Primary E.M.F.	Current.	Secondary E.M.F.
21	138	·242	5·2
20	826	·276	29·7
19	1,237	·642	53·5
18	1,378	·795	64·0
17	1,300	·821	64·3
16	924	·700	51·1
15	63	·340	15·0
14	698	·188	23·7
13	1,138	·587	49·0
12	1,370	·810	63·7
11	1,343	·844	66·0
10	1,073	·771	26·5
9	323	·479	26·5
8	590	.000	17·0
7	1,117	·538	42·8
Observed $\sqrt{\text{mean}^2}$	1,040	·631	49·3
Calculated from curves $\sqrt{\text{mean}^2}$	1,020	·634	49·3

Mean ammeter reading, 10·65

In Fig. 9 are plotted curves deduced from the foregoing observations that show clearly the rate at which energy is given to the transformer, or that the transformer restores to the circuit at all points of a complete alternation for the several conditions under which the transformer was operated. The curves themselves show so clearly this particular part of the performance of the transformer that nothing need be said about them, except to give the percentages of the work given to the transformer that is restored to the circuit by it under the several foregoing conditions: open circuit, 6·8 per cent.; one lamp, 3·9 per cent.; five lamps, ·96 per cent.; 10 lamps, ·36 per cent.

The above observations and data are ample wherewith to compute the various losses of energy that take place in

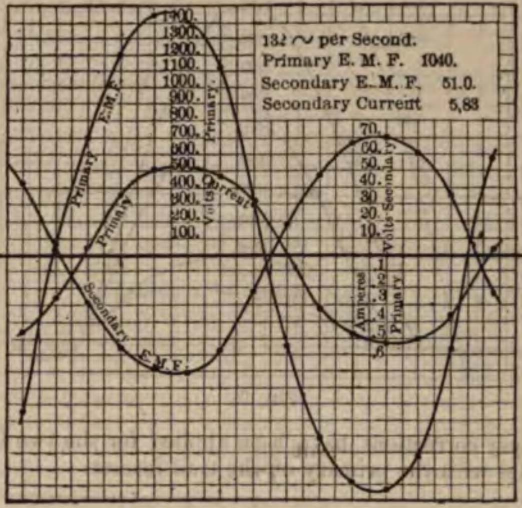

FIG. 6.

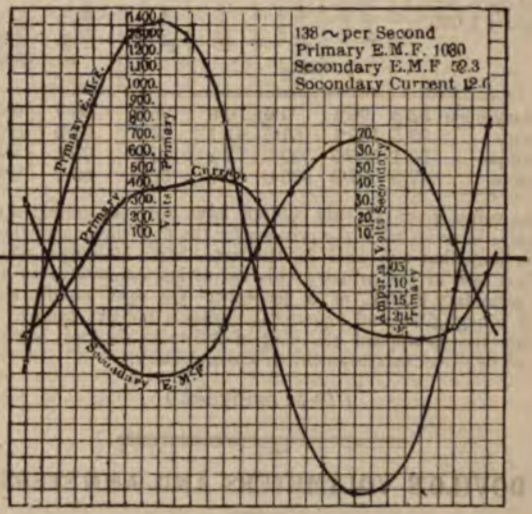

FIG. 7.

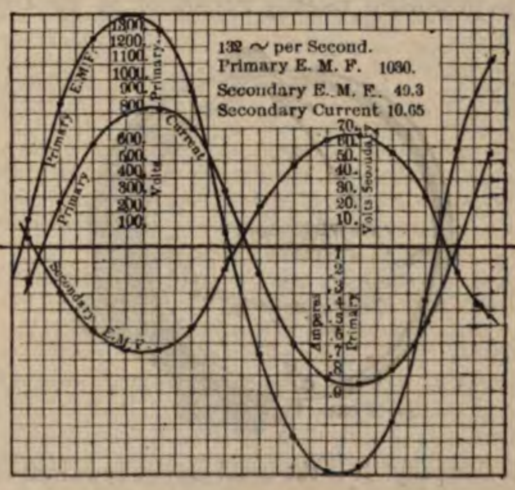

FIG. 8.

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* Paper read before the American Institute of Electrical Engineers, New York, December 17, 1889.

the transformer under the several loads and under no load, and the deduction of the corresponding efficiencies. These values have been computed, and are given in the following table.

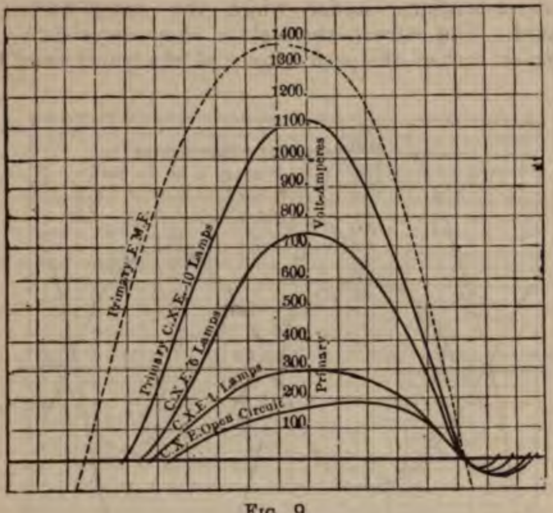

Fig. 9.

Proper corrections have been applied for the two lamps in series with the primary of the transformer.

Secondary E.M.F.* (primary 1,020.)		Primary watts.	Secondary watts.	Efficiency.	Total loss in watts.	Hysteresis loss in watts.	Heating loss.	
							Primary watts.	Secdy. watts.
Secondary open	52.3	96·1	0·0	0·0	96·1	95·7	0·4	0·0
One lamp	52.3	159·1	64·3	41·1%	94·8	93·9	0·9	0·0
Five lamps	50.1	388·6	300·9	77·5%	87·7	83·1	3·3	1·3
Ten lamps	47.5	607·9	325·0	86·6%	82·9	69·7	8·7	4·5

* The values given in this column have not been corrected for the two lamps in series with the primary for the first three conditions and the one lamp that was used for the last. With 10 lamps, where one lamp was used in the primary, this correction amounts to an increase of the secondary E.M.F. of 3 per cent. On open circuit and one lamp it is negligible and 3 per cent. increase for five lamps. When this correction is applied the drop of 3·5 volts obtained is what was observed by direct measurement on the secondary.

(To be concluded.)

DOVILO'S VOLTMETERS AND AMMETERS.

The accompanying is an illustration of Dovilo's voltmeter, an instrument recently introduced by the General Electric Company. It is the usual gravity type instrument, but its great advantage over others in existence are evidenced by the sketch. It is mounted on a cast-iron base inside a substantial metal cover. The dial is 8in. in diameter, and by an ingenious method of fixing the pointer a very open scale is obtained. In an instrument reading from 0 to 25 amperes a $\frac{1}{4}$in. space between each ampere is obtained, whilst an instrument ranging from 50 to 120 volts allows as much space as 1in. for every 10 volts, thus making it particularly suitable for central stations or large engine-rooms, where the possibility of reading an instrument from a distance is often of the greatest importance. In common with other gravity type instruments, it does not require recalibration, and can be left with the current on continuously without harm. Ammeters for measuring current are made of the same open design.

ELECTRICITY IN LONDON STREET CARS.

A paragraph in the *Daily News* has already announced that one of the metropolitan tramway companies is applying for parliamentary powers to run electric cars over its whole system. We have to add that there is in course of formation a large and influential company, with a capital of half a million, for the introduction of electric "traction" throughout an extensive region of the metropolis. We have to say, further, that Liverpool is about to make, with electric cars, such a beginning as, considering the respective sizes of the two towns, will probably for some time leave the Londoners a good way behind the Liverpudlians. The Liverpool people are keen for the new mode of locomotion. To certain advantages which they possess, in respect of cheap raw material, we will refer further on.

At the present time the Liverpool United Tramways and Omnibus Company has a roadway of $61\frac{1}{4}$ miles, over which electricity will by-and-by supersede all other forms of motive force. Let us see what the London mileages are. The North Metropolitan has 41 miles of double track; the London Tramway Company has $19\frac{5}{8}$ miles; the London Southern about 5; the London Street $12\frac{1}{2}$; the North London 12; the South London $13\frac{1}{2}$; the Southwark and Deptford $6\frac{1}{2}$; the West Metropolitan $8\frac{1}{4}$. Thus the total length of the tramways in London is just within 119 miles. The last-named company, the West Metropolitan, is anxious to use electric motors in place of horses. The North Metropolitan, the largest of them all, is looking to a near future, wherein its 2,618 horses will in like manner be displaced, and made available for other kinds of work not less useful, but much less murderous than street "traction." It is calculated that the introduction of the electric motor would liberate 25,000 horses on the existing tramways throughout the United Kingdom. The importance of this result will be apparent from what, in our recent series of articles, was said about the growing scarcity of good horses for military and other purposes. Considering the infinite variety of uses to which it may be applied, electricity as a motive force has a far greater future than electricity as a lighting agent. We hope, before we are done with this fascinating theme, to show, at least in outline, what are its capabilities in "the service of man." In the present article we deal with street cars only. The course of progress from the less perfect systems of locomotion is shown in the history of American street traction. Some 15 years ago New York streets were crowded with omnibuses. The omnibuses have disappeared, and for the use of the new kinds of carriages New York possesses 300 miles of tramways. Philadelphia possesses 450. In the natural course of development the improved roadway comes first. For a time horses are used on the street rails. Then comes steam or wire-rope "haulage." But sooner or later the substitution of a steam-engine for a team of horses proves an unendurable nuisance. The other day a public meeting, held at Finsbury Park, pronounced indignantly against the inconvenience caused by the steam-cars in the region of London, and during the discussion the adoption of electricity was recommended. We know of a steam-car company which has 25 engines to its 27 cars. The electric car would do away with the lumbering, dirty, noisy engines at one swoop. This is what the Americans are doing. Less than two years ago they had 22 electric tramways at work. Before very long the electric motor will be in undisputed possession of the scores of thousands of miles of street rails in the cities and towns of the United States. Against the 22 enterprises in America, we had, at the time, only four in England—one in Portrush, one in Blackpool, one in Brighton, and one in Bessbrook. We have now to add the "Electric Traction Company Limited," which lately began operations on a small section of the North Metropolitan Tramway Company's system. This electric company has six cars at work. It has victoriously passed its experimental stage.

Very few, indeed, of the 4,000,000 inhabitants of London have any notion of what the experimental stage meant. For one thing, it meant five years' continuous and costly effort, more or less resembling a groping in the dark. The great problem was how to invent an electric mechanism which should contain the greatest amount of force with the least possible "leakage," in the smallest space. As the result of long and patient trial came the Immisch motor, so called after its inventors, whose wonderful feats in the introduction of electric force into the under-world of miners are now well known to scientific and commercial men. The Immisch motor is pronounced by competent judges to be by far the best—that is to say, the most compact, handy, and economical—ever applied to street traction. The scientific people having been satisfied with it, the question was how to test it on the public highways. The North Metropolitan Company promptly, and with a warm enlightened interest in this new improvement which they have maintained ever since, placed at the disposal of the electricians the tramway section extending from Canning Town railway station to Greengate, Plaistow. In choosing the most difficult and most costly section in their whole system, the North Metropolitan Company did wisely. The working capacity and saving value of the new mode of locomotion should be tested to the utmost. As a matter of fact, the Canning Town Greengate section, taken by itself, would never have paid the North Metropolitan Company. The losses upon it were covered by the general profit over the entire system. The new Electric Car Company undertook to work this section of the line at the rate of 4½d. per mile, paying its own drivers, and leaving to the North Metropolitan Company all profits above that figure. The undertaking has been completely successful. Of course, considering that this section is, as already said, the worst, it follows that the Electric Company, if it had the entire system to run over, could very well afford to do the work at a much cheaper rate. The average cost of horse traction over the North Metropolitan system may be taken at 6½d. per mile. But, taking the whole of London, there are much higher averages than that. We cannot at this moment verify the figures, but we believe that a penny per mile reduction in its working expenses means to the North Metropolitan Company an addition of about £26,000 to its annual income. So much for the financial value of street locomotion by electricity.

We have visited the Electric Car premises at Greengate. They are a transformed mews. In place of horses there are electric batteries; muscular "energy" has given place to electric "current"; the "dynamo" has superseded the box of oats and chopped hay; the "cell" takes on its "charge" where erstwhile the friend of man crunched his grain; and, instead of the tight-breeched stableman with his sleeves up, and his braces about his hips, and his familiar talk of "'osses," there is the electrical foreman who is strong on "volts" and "amperes," who speaks mathematics, who looks to the "insulation" of his wires where his forerunner would have currycombed his cattle, and before whom the unscientific stand abashed. An embodied mystery, an incarnated tale of science, is this successor of the stableman, as he stands there, with his hands in his pockets, 5½ft. to 6ft. in his boots. Question him, if you may, overcoming, if you can, your not unnatural shyness; but don't contradict him, lest peradventure your intellectual sterility becometh manifest, and he sitteth him down in the chair of the scorner. He hath not caught leviathan with a hook; but he hath done more, he handleth with easy familiarity the most terrific force in the universe. Imbibe his wisdom, but if you mean to parley with him first take a month's good hard grind, say, at Timzelmann's new book on electricity. The foregoing reflections apply to overseers in general.

And now for our trip. But, before we start, let us cast a glance around the depôt. A car has just come in to be "charged" afresh. It is shaped exactly like any other car. Down come half-a-dozen flaps, or small doors, along its side. Out come the half-a-dozen sets of exhausted cells, and on again are thrust by the attendant in charge as many fully-charged cells. Then up go the little doors, and the car looks precisely like any other. The cells are concealed below the inside passengers' seats. The whole operation lasts only three minutes; and when the interchange of cells takes place the car can run 35 miles before it requires a fresh charge. The electric current is generated on the premises in the same way as in the electric lighting stations described in a former series of articles. When generated it is "stored" in the cells above-named. From these cells—hidden beneath the seats—the current runs to the "motor" beneath the floor and between the wheels; there the "current" becomes "mechanical force," and the "motor" sets the wheels a-going. With the appropriate mechanism this "current" would manifest itself, not as mechanical force, but as light—such as we have formerly described it. In fact, this Protean force assumes the two guises on the selfsame car. The current not only turns the wheels; it also takes the form of light inside the incandescent lamps, under which as you sit inside the car you may read the smallest print.

We glide out of the station noiselessly, away into the high road. The car can run at a speed of 20 miles an hour, but of course that is not permitted. The facility with which it can be manipulated is surprising. In an instant it can be made to crawl along at a snail's pace, or go away at full speed. Its driver once drove a "'bus." He much prefers electricity to equine muscle. And he learnt how to control his electric car without any trouble in two or three days' time. On this section of the tramway there is a very stiff gradient. The electric car goes up it with the greatest ease. In going down the incline the "current" is turned off; the car goes by its own momentum, so that "energy" is saved; whereas, even with the drag on, horses would have had to run all the same, thus expending their energy uselessly. Each electric car has displaced 60 horses—which, however, have found employment elsewhere. Each electric car carries 52 passengers, including outsides and insides. And each car can be used as a locomotive for ordinary cars. A new electric car can be built and fully equipped in about 10 weeks; an ordinary horse car can be converted into an electric car in four. Of these horse cars the North Metropolitan Company owns 350.—*Daily News.*

SUCCESS OF THE BRADFORD ELECTRIC LIGHT STATION.

Bradford Town Council, which was the first corporation in the kingdom to establish works for the commercial supply of electricity for lighting and trade purposes, has met with such success in its experiment that, although the installation was only inaugurated at the end of September last, and the area of supply is for the present confined to a quarter-mile radius from the centre of the town, the demands are greater than the plant can supply. At the monthly meeting of the Council on Tuesday, Alderman Frederick Priestman, chairman of the Gas and Electricity Supply Committee, proposed the adoption of a resolution authorising the expenditure of £10,000 in extending the plant. In doing so he reminded the Council that some few weeks ago the committee obtained permission to secure additional borrowing powers to the extent of £30,000, and merely awaited the inspector's formal report. When they started the installation at the end of September they had only demands for 330 amperes, but they were now supplying 1,520 amperes. This had exceeded the most sanguine expectations of the members of the Council. They had now increased demands which they could not grant, as already the apparatus was somewhat overstrained. This being the state of affairs, the committee was anxious that ere next winter came round they should be able to supply the demand. Besides the outside application they had also had a requisition through the Mayor from the Recorder asking for the electric light being placed in the Borough Court, and the School Board also required it. The only thing he was short of to-day, said the alderman, was a financial statement. The buildings erected were sufficient for supplying four times more electric light than they did at present, and consequently the fixing of further apparatus would go towards making the system pay. At present they charged 5d. per unit for the electric light, but if that did not pay, it would be their clear duty to increase the price. Mr. D. Barker seconded the resolution, and said he had every reason to believe that if the committee were not making money over the electrical works they were not losing any, and he thought the proposed extension a wise move. Mr. Galloway opposed the resolution. He said that when the electric lighting scheme was first mooted the expenditure was to be limited to £20,000, but now another £10,000 was to be spent, and there was a further £20,000 in the background. He thought the committee should stay their hands until the experiment had been fairly tried, and it were seen if it were a financial success. Mr. Newboult expressed satisfaction at the proposed extension of the electric lighting. It would be a great boon to shopkeepers, who now suffered very much in health from the vitiated atmosphere caused by the use of gas. Mr. Shackleton criticised the construction of the electricity works, and argued that economy and good judgment had not been shown.

Alderman Priestman, in answer to Mr. Galloway, said that gentleman need not have any fear of the electricity works swamping the gas works, and pointed out that during the past six months the consumption had increased at the rate of 6 per cent.—The minutes were then adopted.

COMPANIES' MEETINGS.

UNITED RIVER PLATE TELEPHONE COMPANY.

An extraordinary general meeting of this Company was held on Thursday, at Winchester House, Old Broad-street, Lord Thurlow in the chair, to consider resolutions—(1) for the creation and issue of debentures or debenture stock providing for the payment of principal sums not exceeding in the aggregate £200,000, provided that so long as any of the existing debentures which fall due on January 1, 1907, shall be outstanding or uncancelled, "the nominal amount of the new debentures or debenture stock from time to time issued under this resolution, together with the nominal amount of the existing debentures so outstanding or uncancelled, shall not exceed the sum of £200,000"; and (2) authorising the Directors to redeem all or any of the existing debentures by exchanging them for any of the new debentures or debenture stock, or by payments in cash, or in such other manner, and at such premium or rate of exchange as they should think expedient, and pending the issue of the new debentures, or debenture stock, authorising the Directors to borrow on such terms as they might think fit any moneys for the purpose of redeeming any of the existing debentures, or for any other purposes of the Company.

The **Chairman** stated that the object of the meeting was to authorise a financial operation of twofold significance. In the first place, it was to increase the working capital by the sum now required for the extended operations of the Company, and, secondly, to enable them to take that opportunity of reducing the rate of interest they paid on their debentures. The present position of the Company did not justify their continuing to allow 7 per cent. on their debentures, and they found that there would be no difficulty in converting them into a 5 per cent. charge. The net result of the operation, when it was carried out to the extent they proposed at the present time, would be to give the Company an issue of £150,000 for only £500 a year more than they now paid for the use of £100,000. He thought that that was a very favourable financial operation. When they began business nearly three years ago the number of the subscribers was 3,200, the capital being £250,000 in shares, and £50,000 in debentures. The number of subscribers on October 31 last at Buenos Ayres, La Plata, and Rosario was 47 per cent. more, and the present capital was £290,000 in shares and £100,000 in debentures. The position of the Company was now very much stronger than it was when they began work. They had been asked the estimated cost of the proposed trunk line between Buenos Ayres and Rosario. He could only say that the cost would depend on circumstances. The trunk line would follow the line of the existing railway between Buenos Ayres and Rosario, and he could assure them that it would be constructed on the most economical principles consistently with efficiency. The extraordinarily high rate of gold at Buenos Ayres had curtailed their dividend by nearly one-half at the present time, but he thought it must be satisfactory to the shareholders, on the whole, to see that the prosperity of the Company had enabled it to withstand so great a strain.

On the motion of the **Chairman,** seconded by **Mr. J. Irving Courtenay,** the resolutions were unanimously agreed to.

NEW COMPANIES REGISTERED.

Fowler, Lancaster, and Co., Limited.—Registered by Francis Minchin Voules, 2, Metal Exchange-buildings, E.C., with a capital of £22,000, in shares of £10 each. Object: to carry on the business of electrical engineers, manufacturers, and contractors in the United Kingdom, or any such country or place. The first subscribers are:

	Shares.
Arthur Mackenzie, Temple-chambers, Temple-avenue, E.C.	1
A. E. Shiel, 30, Dayton-grove, Peckham, S.E.	1
Herbert H. Collins, 67, Lombard-street, E.C.	1
C. W. Rawlinson, 11, Lincoln's-inn-fields, W.C.	1
W. M. Pyke, Metal Exchange-buildings, E.C.	1
R. W. Bonsor, 11, Lincoln's-inn-fields, W.C.	1
C. A. Elgood, 48, Lincoln's-inn-fields, W.C.	1

The names of the first Directors shall be nominated in writing by a majority of the subscribers to the memorandum of association. George Vaughan Fowler and Edward Wm. Lancaster shall be the first managing directors of the Company.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The traffic receipts for the week ended January 10 amounted to £4,728.

Western and Brazilian Telegraph Company.—The receipts for the past week, after deducting the fifth payable to the London Platino-Brazilian Company, were £3,434.

Eastern Extension, Australasia, and China Telegraph Company, Limited.—This Company notify that the interest on their six per cent. debentures, due February 1 next, will be paid on and after that date at the Consolidated Bank, 52, Threadneedle-street, E.C.

Direct United States Cable Company, Limited.—The report of this Company for the six months ended December 31 states that the revenue (still subject to revision), after deducting out-payments, amonnted to £42,356, against £34,188 (after similar deductions). Interim dividends of 3s. 6d. per share for the quarter ended September 30, and of 3s. 6d. per share for the quarter ended December 31, together amounting to £21,248, have been declared, and £8,317 has been carried forward.

Eastern Telegraph Company, Limited.—The report for the half-year ended September 30 states that the revenue amounted to £351,014, from which are deducted £87,730 for the ordinary expenses, and £49,634 for expenditure relating to repairs and renewals of cables, etc. After providing for income-tax, there remains £208,925, to which is added £974 brought from the preceding half-year, making a total available balance of £209,899. From this balance there have been paid: Interest on debentures and debenture stock, dividend on preference shares, and two interim dividends of 2s. 6d. per share each on ordinary shares, leaving £61,151, which is carried forward.

Companies of the Month.—The following electrical companies have been registered during the past month:—

Birmingham Electric Supply, Limited, £5 shares	£100,000
Electrical Standardising, Testing, and Training Institution, Limited, £5 shares	10,000
Foreign and Colonial Electrical Power Storage Company, Limited, £5 shares	100,500
Morris Bros., Limited, electricians, £1 shares	5,000
Syndicate of Electrical Engineers, Limited, £5 shares	10,000
Wrexham and District Electric Supply Company, Limited, *£5 shares*	20,000

PROVISIONAL PATENTS, 1890.

JANUARY 6.

217. **Improvements for regulating carbons in arc lamps.** Max Binswanger and William John Croft, 45, Chapel-street, Salford, Manchester.

232. **Improvements in electric motors and dynamo-electric machines.** John Hopkinson, Edward Hopkinson, and George Annesley Grindle, 47, Lincoln's-inn-fields, London.

JANUARY 7.

241. **An improvement in telephone switchboards.** Alfred Whalley, Helsby, near Warrington, Cheshire.

249. **Improvements in dynamo-electric machines.** William Falconer King, 154, St. Vincent-street, Glasgow.

261. **Improved electric truss.** George Thomas Rick and William Reginald King, 34, Chandos-road, Stratford, Essex.

272. **Improvements in electro-magnetic despatch apparatus.** Reginald Haddan, 18, Buckingham-street, Strand, London. (John Thomas Williams, United States.) (Complete specification.)

274. **Improvements in electric bells.** August Natterer, 18, Buckingham-street, Strand, London.

302. **Improvements in secondary or storage batteries and in the manufacture of plates therefor.** Henry Harris Lake, 45, Southampton-buildings, Middlesex. (Phœbus Harry Alexander, United States.) (Complete specification.)

303. **Improvements relating to secondary batteries.** Henry Harris Lake, 45, Southampton-buildings, Middlesex. (Phœbus Harry Alexander, United States.) (Complete specification.)

JANUARY 8.

350. **Improvements in the formation of electrodes for use in primary and secondary electric batteries.** Ludwig Epstein, 46, Lincoln's-inn-fields, London.

JANUARY 9.

407. **Improvements in electrical automatic machines.** Hubert Samuel Heath and Roland Isaac Barnes, Excelsior Cottage, Lea Bridge Gardens, Leyton, Essex.

425. **Improvements in the construction and laying down of high potential electric mains.** James Charles Richardson and Henry Moon, 23, Claremont-square, London.

JANUARY 10.

475. **Improvements in or connected with apparatus for telegraphic and telephonic communication.** Joseph Sack and the firm Von Maltitz and Ziesel, 433, Strand, London.

488. **Improvements in and connected with primary batteries.** Marcel Sappey, 166, Fleet-street, London.

JANUARY 11.

534. **Improvements in electrical switches.** Gustav Binswanger and Herbert John Coates, 71, Queen Victoria-street, London.

SPECIFICATIONS PUBLISHED

1881.

4202. **Incandescent electric lamps.** Swan. 6d. (Third edition.)

1888.

16852. **Electric circuits.** Goolden and others. 8d.

18812. **Distributing electricity.** Yorke. 8d.

1889.

1420. **Secondary batteries.** King. 8d.

2003. **Electric-regulating apparatus.** Shepard. 8d.

2742. **Switches for suspended "arc" lamps.** Wagg and Hudson. 6d.

14991. **Electricity meter.** Blathy. 11d.

17765. **Electro magnetic despatch apparatus.** Haddan (Williams). 6d.

18322. **Electric coin-freed machines.** Cumming. 6d.

18365. **Primary and secondary batteries.** Entz and Phillips. 6d.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Anglo-American Brush	—	3
— Pref.	—	2
India Rubber, Gutta Percha & Telegraph Co.	10	17¾
House-to-House	4½	5
Metropolitan Electric Supply	—	
London Electric Supply	5	4
Swan United	3½	5
Telegraph Construction	12	45
— 6%, 1889	100	105
National Telephone	5	6¼

NOTES.

Shallenberger Meters.—Over 11,000 of the Shallenberger electric meters are now in use in the United States.

Arc Lamps at the Post Office.—Sixty Brockie-Pell arc lamps have been just ordered for the General Post Office.

Leipsic.—The Polytechnic Society of Leipsic has decided to open a permanent technical exhibit in that town from the month of March next.

Mining Exhibition.—An international mining exhibition is planned to be held in London at the Crystal Palace during this summer.

Society of Arts.—The second Cantor lecture on "The Electromagnet," by Prof. Silvanus P. Thompson, will be given on Monday next, at 8 p.m.

Electric Railway in Germany.—An electric railway will shortly be opened between Elberfeld and Barmen on the overhead conductor system.

Guatemala.—The electric light has been adopted to such an extent in the towns of Guatemala that the importation of mineral oils has fallen off 50 per cent.

Inspector for Bath.—The Electric Lighting Committee of Bath will shortly have to appoint an electrical inspector for that town in accordance with the Act.

Frankfort Exhibition.—The international electrical exhibition announced to take place this year at Frankfort-on-Main has been adjourned until the spring of 1891.

East African Cable.—The Eastern Telegraph Company announces the opening for traffic of a new cable between Zanzibar and Mombassa, on the east coast of Africa.

Chapel Royal, Savoy.—An installation of the electric light is being introduced into the Chapel Royal, Savoy, and in consequence it is closed till the second Sunday of next month.

Dundee.—A canvass of consumers has been taken at Dundee. It is thought the committee will advise that the matter should be left to the various boards of the district to take such action as they think fit.

Gas Advanced.—At Corbridge, Northumberland, the gas company have advanced the price from 3s. 9d. to 4s. 7d. per 1,000 cubic feet. Now is the time for some electrical firm to broach the subject of electric light.

Glasgow.—The students' union bazaar at the university buildings, Glasgow, was lighted very successfully with a number of 16, 32, 50, 150, 200, and 500 c.p. lamps by Messrs. Norman and Son, Limited, of Glasgow.

Aluminium in Austria.—At Gastein, the Austrian health resort, an installation for the electrical manufacture of aluminium is being laid down. A force of 6,000 h.p. will be available from the local falls of Gasteiner Ache.

Gravesend.—The Parliamentary Special Committee of the Gravesend Town Council recommend the Council to take the necessary steps, at the first available opportunity, to obtain a provisional order to supply electricity to the district of Gravesend.

County Council Inspectors.—The applications for the post of electrical inspector to the London County Council have been considered and reduced to a small number. The selected candidates will attend the meeting of the Council next Thursday week.

High Tension.—The Oerlikon Works, Zurich, are to be considerably enlarged, and power is to be obtained from a waterfall at Burlach, some 12 miles distant. They are credited with the intention of transmitting the power by means of alternate currents of 25,000 volts.

French Academy.—The Academie des Sciences at Paris has awarded the following prizes in the domain of electricity: the Prix La Caze to Prof. Hertz for his researches in the direction of electric undulations; the Prix Montzon to M. d'Arsonval for his researches in electro-physiology.

Water Power in Italy.—The Edison Continental Company have utilised the waterfall at Paderno to supply the power for a central electric light station. The Societa Electrica Industriale is also applying for a concession for the utilisation of water power, but no particulars are yet given respecting it.

New Zealand.—At the New Zealand and South Seas Exhibition, held last month in Dunedin, the fernery was lit up by the electric light, with great success. The installation was laid down under the direction of Captain Falconer, of the submarine mining and torpedo branch of the Defence Department.

Rochester.—The application for a provisional order for the town of Rochester by the Rochester, Chatham, and District Electric Lighting Company came before the Town Council. Some alterations suggested by Mr. Moulton, Q.C., were noted, and subject to these being embodied the consent of the Council was granted.

Oxford.—It has been decided to leave out the whole of the lighting clauses in the Bill for the Oxford Town Council. Two companies are seeking powers to light the town, and it was thought not well to oppose these, as the town authorities themselves did not feel it desirable to enter upon the work themselves.

Transmission of Power in Italy.—Advices from Schio state that measures are in progress for transmitting 300 h.p. of energy over 5½ kilometres (about 3½ miles). During the next four months it is said that an attempt will be made to transmit the same amount over the distance of seven kilometres in the same neighbourhood.

Purifying Coal Gas.—Mr. D. A. Graham, engineer of the Dunedin Gas Works, has applied, says the *Gas World*, for a patent for the generation of oxygen by the decomposition of water by means of electricity, and the applying of the oxygen so produced to the revivification of lime and oxide of iron used in the purification of coal gas.

London Chamber of Commerce.—A meeting of the Electrical Trades Committee will be held at the offices of the London Chamber of Commerce, Botolph House, Eastcheap, on Monday next, at 3.30 p.m., to consider the Edinburgh Exhibition, B.A. screws, county council, surveyors and their powers, obstructive orders, and other matters.

Electric Tramways in Paris.—The experimental electric tramcars are now run regularly upon the line from the Madeleine to Levallois. It is understood that the Compagnie des Tramways-Nord is intending to purchase a license from the Accumulator Company for the application of the Faure-Sellon-Volckmar cells for traction on all its cars.

Train Lighting in Austria.—The Austrian North-Western Railway has commenced a series of trials of the electric lighting of its carriages by means of accumulators supplied by the Oerlikon Works, Zurich. Each carriage contains four lamps of 10 c.p., and four lamps of 6 c.p., and the cells are fixed in a special compartment under the carriage.

Thomson-Houston Cars.—The Thomson-Houston Electric Company is actually 700 street car motors behind with its orders, and this notwithstanding it has doubled its factory capacity twice during the past year. This fact gives more idea of the wonderful progress in electric tramways in America than even the publication of statistics of railroads.

Ship Lighting.—A new steamer, the "Tyrian," built of steel at Southampton, for the inter-colonial mail service of the Union Steamship Company, by Messrs. Day, Summers and Co., has been launched this week. She is classed 100 A1 at Lloyds, fitted with triple expansion engines of 1,100 h.p., and is furnished throughout with electric light.

Private Bill.—The Examiner of Private Bills has had before him for consideration a Bill for authorising the House-to-House Electric Supply Company to erect and maintain electric lines and works within the City of London. The initial capital of the company is £350,000. It is proposed by the company to light the public lamps at a price to be fixed by agreement.

Caterham.—A movement is to be brought forward before the local authority for lighting the streets and roads of Caterham. The present illumination of the town is in a very primitive state, one gas-lamp, the result of a lady's gift to the place, being the only means of illuminating after dark a town with 4,500 inhabitants, not including 1,500 military residents at the depôt.

Subway Railways.—The Bills for the London Central Subway Railway and the Kensington and Paddington Railway have been abandoned for the coming session, leaving out of the five Bills originally proposed only one, that of the Central London Railway—Bayswater to the Monument—of which we lately gave full particulars of the method intended to be employed.

Moss-Covered Electric Lamps.—A florist in the West-end has had the happy thought of hanging trails of moss over and around the electric lights in his windows. Nothing could be more gracefully pretty than their soft environment. The green and yellow tints of the delicate leaves form a lovely veil for the light, which glimmers through them without being diminished.

New Electric Railways.—The Series Electrical Traction Syndicate, Limited, have concluded a contract to work the North-Western and Midland District Auxiliary Railway Company's line, 7¼ miles in length, by electricity. Overhead conductors will be employed, and both goods and passenger traffic will be worked. They have also contracted for the equipment of a further fifteen miles of tramroads at present under construction.

Electric Doors for Theatres.—The Tremont Theatre, Boston, U.S., is now fitted with electric doors, which can be opened by simply touching one of eight push buttons situated in convenient places in the theatre. On the slightest alarm 17 sets of folding doors are immediately and simultaneously thrown open by the electric circuit, doing away in a large measure with the danger of being *trampled to death in* cases of panic.

Cadiz.—A contract was signed on the 30th of last month, between the Municipality of Cadiz and Senor D. Francisco de la Viesca, for the public lighting of the streets by electricity. Arc lamps are to be used in the principal squares of the city, and incandescent lamps in the streets. The contract is to endure for twenty-five years, after which time the installation is to revert to the Municipality.

Brussels.—The municipal authorities of Brussels have decided, upon the representations of M. Van Rysselberghe, not to grant concessions for electric lighting to the German companies who have applied through their local agents, and to whom at one time it was thought a large part of the work would have gone. They have not as yet, however, passed any resolution in favour of granting the contracts to the Belgium firms who have submitted plans.

Overhead Wires.—The Sanitary and Parliamentary Bills Committee of the St. James's Vestry recommended that a communication be addressed to the London County Council on their London Subways and Overhead Wires Bill, pointing out that under the Bill as drawn the existence of overhead wires will be legalised and infinitely prolonged, and urging the necessity of the Bill being so amended as to provide that within some specified time all overhead wires shall be placed underground. This was carried.

Public Record Office.—The electric light, which has recently been introduced in the Public Record Office, is now in working order. The public search rooms and corridors are lighted by 110 incandescent lamps, of which 30 are employed in the Literary Search Room. Different opinions will probably always prevail, says the *Athenæum*, as to the advantage and safety of this light for purely manuscript researches; but in the present case, though the lamps are hung too low, it is at least the best of its kind obtainable.

Richmond.—The Highway Committee of the Surrey County Council reported at the meeting on Tuesday that they had instructed the clerk to dissent from the schemes of the Richmond Electric Lighting and the Brush Electrical Engineering Companies for lighting Richmond. They further reported that in their opinion a clause should be inserted in the other electric lighting schemes providing that no overhead wires should be erected and that underground wires should be laid. The clerk was empowered to take the necessary steps.

Street Lighting in Newcastle.—The Newcastle Corporation Lighting Committee will not carry out their implied threat of lighting the street lamps by means of electricity, for they have agreed with the gas company, and renewed the contract. Nevertheless, they mean to try electric lighting on a small and experimental scale. They propose to put the new light into the big lamps in the large open spaces at the top of Westgate Hill, the Central Station, the Cattle Market, and Barras Bridge. This experiment ought to yield satisfactory results.

Hanley.—At the Hanley Town Council a resolution was adopted empowering the Electric Lighting Sub-Committee to prepare and forward to the Board of Trade the objections of the Corporation to the application of the Birmingham House-to-House Electricity Company for a provisional order to supply electricity for lighting purposes within the borough; and it was further resolved that the town clerk be instructed to take the necessary steps to apply to the Board of Trade for the granting to the Corporation of a provisional order to supply electricity for lighting purposes within the borough.

Wandsworth.—The General Purposes Committee of the Wandsworth District Board reported that they had before them the draft provisional orders for the supply of electricity in this district from the Metropolitan Electric Supply Company, Limited, and the Wandsworth District Electric Lighting (House-to-House) Company, and recommended that a committee consisting of two members from each parish in the district be appointed to consider the same and report thereon to the Board. The recommendation was unanimously adopted, and a committee appointed in accordance with the recommendation.

Buttering Bread by Electricity.—The latest and most unique invention is a machine for buttering bread. It is used in connection with a great patent bread-cutter, and is intended for use in prisons, workhouses, and other reformatory institutions. There is a cylindrical-shaped brush which is fed with butter, and lays a thin layer on the bread as it comes from the cutter. The machine can be worked by hand, steam, or electricity, and has a capacity of cutting and buttering 750 loaves of bread an hour. The saving of butter and of bread and the decrease in the quantity of crumbs is said to be very large.

Scarborough.—The minutes of the Electric Lighting Sub-Committee of the Scarborough Town Council, dated the 30th ult., stated that the sub-committee considered the question of appointing an electrical engineer to advise with the Corporation on the subject of electric lighting, and the applications for provisional orders now lodged with the Board of Trade; and instructions were given to the town clerk to communicate with Mr. Bernard Drake, electrical engineer, London, as to advising with respect to the applications for provisional orders, and also to ascertain what course of action is being pursued in other towns in a similar position to Scarborough with regard to electric lighting.

The Gatti Central Station.—On Monday the Examiner for Private Bills had before him, for proof of compliance with the standing orders of Parliament, the Strand Electric Lighting Bill, promoted for the purpose of authorising Messrs. A. and S. Gatti to erect and maintain electric lines and works and to supply electrical energy within the parishes of St. Paul, Covent-garden, and St. Clement Danes; and the St. Martin's-in-the-Fields Electric Lighting Bill, to authorise Messrs. A. and S. Gatti to erect and maintain electric lines and works, and supply electrical energy in the parish of St. Martin-in-the-Fields. Both Bills were found by Mr. Campion to have complied with the standing orders.

The Reading Free Library.—Alderman Hill, in moving the adoption of the minutes of the Free Library Committee before the Reading Town Council, said the gas bill was formerly £79, and the contract for electric lighting, including the entire cost of installation, would be £80. He need not go into the question of the great improvement that would be effected in the ventilation of that stuffy room. The light, of course, would be an experiment, but the committee had gone very thoroughly into the matter, and they were satisfied that the light would be an improvement on the present system. There would be five arc lights of 1,200 c.p. or 18 incandescent lamps. Alderman Messer seconded the motion, which was carried.

Travelling Sidewalks.—The last Yankee notion for locomotion in cities is to benefit belated travellers, and is to consist of a series of travelling sidewalks, composed of slates on an endless chain. Electric motors stationed at suitable distances are to furnish the power to move these sidewalks at a rate of four miles an hour. As the average pedestrian possesses a three-mile gait, this, it is thought, will enable a man to travel easily at the rate of seven miles an hour. Only half the sidewalk will travel, that portion nearest the house line being stationary. It would be interesting to see the ordinary belated traveller trying a three-mile gait on a moving path. Most of them would prefer to sit down, as the story has it, and wait till their doorstep came round. The notion is ascribed to a Pittsburg genius.

Liverpool Physical Society.—At a meeting of the society, Mr. Norvan Tate, F.I.C., F.G.S., in the chair, a paper was read by Mr. Charles H. Yeaman, A.Inst.E.E., on "Sir W. Thomson's Measuring Instruments." The paper was a *resumé* of Prof. Thomson's work in the field of electric measurement, and briefly pointed out the four classes of instruments: (*a*) those of the "electrometer" or open circuit class; (*b*) those of the "galvanometer" or magnetostatic class; (*c*) those of the "dynamometer" or coil class; (*d*) those of the "solenoid and coil" or induced magnetism class. The evolution of the present set of standards was traced, and several examples of these were on the table, through the courtesy of Messrs. Holmes and Vaudry and Mr. Charles W. Cox. The paper was illustrated with some diagrams, and a short discussion followed.

Aberdeen.—The borrowing powers under the proposed Bill and provisional order for Aberdeen are £50,000. The Gas Committee of the Town Council state that the Scottish House-to-House Company has lodged a provisional order, to which the Council's consent has already been refused, and that in due course objections will be lodged. They also report that at the meeting of the committee held on December 30 last, the town clerk submitted a letter, which he had received from the Electric Installation and Maintenance Company, Limited, containing a proposal on the part of the company to undertake the construction of the necessary plant, and maintain and work it for a fixed period on certain terms. The committee, however, directed that a reply should be returned to the effect that the Council are not in a position at present to enter into negotiations on the subject.

Electric Tramway for Rome.—The Roman Tramways Society has concluded a contract with the Series Electrical Traction Syndicate to make experiments upon the line on the Via Flaminia outside the Porta del Popolo. This line, says the correspondent of the *Standard*, runs to the Ponte Molle, a spot much frequented by the Romans in summer and on all holidays, and there are numerous restaurants and pleasure-grounds skirting the Tiber there. The new course, on which the May races are run, is a little beyond, and is another cause of making this route often so crowded as to be almost impassable. M. Carl von Buch, director of the company, and several English engineers have come to Rome expressly to superintend these experiments, which are made with the consent of the Prefect and Syndic of the city. Nothing is waited for but the arrival of the special carriages and apparatus from London to commence the running of the electric tram.

The British Museum.—The arrangements for lighting the public galleries at the British Museum by electricity are now completed, and were inspected on Wednesday by the trustees at a meeting specially held for that purpose.

They have been carried out by Messrs. Siemens under the direction of the principal librarian. The general principle adopted is the employment of the arc light in the galleries, where large objects are exhibited, as in the Elgin room and the Assyrian and Egyptian galleries downstairs, while the ethnological gallery, and the bronze and vase-rooms of the Greco-Roman department upstairs are lighted by a system of numerous glow lights, fixed longitudinally along the joists of the ceiling. The effect in both cases is good, and the illumination is decidly superior to that of average London daylight in winter. It is intended that one half of the galleries shall be open to the public every evening from eight to ten o'clock.

Luminous Fountains.—The success attending the exhibition of luminous fountains will, it is not unlikely, result in a considerable development of this class of decoration for public parks. On the Continent especially the attractiveness of the displays have forcibly struck the authorities of those towns whose chief *rôle* is supplying attractions to pleasure-seekers, and it is very probable that during the ensuing season several installations of luminous fountains will be added to the other beauties of some of these towns. Amongst others, the larger and more fashionable hotels are not backward in adopting this pretty addition to their other attractions, and for several months past the Grand Hotel at Paris has transformed its fountain in the courtyard, where celebrities of all nations are wont to congregate, into a luminous fountain, flashing at night with all sorts of varied colours. A rich Parisian, M. Gaston Menier, has actually fitted up one of these fountains on his dining-table, the works of which are smothered in a huge bouquet, a tasteful and novel addition to the enjoyment of a dinner. A large café in the Tenth Arrondissement has also had a luminous fountain fitted up. In this, instead of the water being lighted from below, the lights are thrown upon the playing masses of water from above. The fountain is an elaborate reproduction of the sculptured fountain of the Paris Exhibition on a smaller scale.

The Brazilian Rubber Trade.—On Tuesday, under the presidency of Mr. F. Fleischmann, a meeting of merchants, manufacturers, and others interested directly or indirectly in trade with Brazil, and more especially in the import of rubber and other products from the province of Para, was held at the London Chamber of Commerce, "to protest against and to consider the best means of procuring the withdrawal of the arbitrary concession by the Provincial Government of Para, under which the Companhia Mercantil (a private trading corporation) has power to compel all other export buyers of rubber to pay 20 reis for each kilogramme of rubber purchased by them from the receivers." It transpired that a memorial to Lord Salisbury setting forth the detrimental results to British trade generally of the monopoly granted to the Companhia Mercantil had been signed by some 50 to 60 firms. In the course of the discussion which took place, it was stated by one of the merchants that the chief objection was that the additional tax was payable not to the Government, but to a trading company which competed with the payers of the tax in the rubber business. A resolution approving the memorial, and requesting the executive committee of the London Chamber of Commerce to convey it to Lord Salisbury, with a statement of the case, was unanimously adopted. The memorial set forth, amongst other considerations, that as the imports of Para rubber into the United Kingdom amounted to about 6,000 tons per annum, the monopoly of the Companhia Mercantil was highly detrimental to the interests of British trade, besides being unjust and contrary to all precedent and commercial usage. The memorial concludes with a request to Lord Salisbury to direct H.M.'s Minister in Brazil to take such steps as might be possible to secure the withdrawal of the concession granted to the Companhia Mercantil.

Leeds.—A joint meeting was held on Monday in the Leeds Town Hall of the Parliamentary Committee, the Electric Lighting Committee, and a Sub-Highways Committee, for the purpose of considering the provisional orders sought by the several companies desirous of obtaining powers to light the borough by electricity. The Mayor (Alderman Emsley), who is chairman of the Parliamentary Committee, presided. Applications for provisional orders have been made to the Board of Trade by the National Electric Supply Company, Limited, the Yorkshire House-to-House Electricity Company, Limited, and the Electric Installation and Maintenance Company, Limited. The town clerk read two resolutions which he had prepared under the Electric Lighting Acts of 1882 and 1888, the one refusing admittance to the borough of the companies, and the other admitting them under certain restrictive conditions, in the interests of the inhabitants. There was a long discussion with reference to these. Alderman Scarr moved the following resolution: "That the Council be recommended to consent to one or more of the electric lighting provisional orders of which notice has been given, subject to such clauses being inserted for the protection of the Corporation as may be deemed advisable." Alderman Spark moved as an amendment: "That the Council, as the local authority within the meaning of the Electric Lighting Acts, 1882 and 1888, be recommended to refuse its consent to the granting by the Board of Trade of provisional orders authorising the construction of works and the supply of electricity by the National Electric Supply Company, Limited, the Yorkshire House-to-House Electricity Company, Limited, and the Electric Installation and Maintenance Company, Limited, respectively within the borough of Leeds, and that the Council be recommended, at the end of six months, referred to in the resolution passed on October 2, to instruct the Electric Lighting Committee to report upon the question of electric lighting with full information upon all improvements which have been made in supplying the light up to that time." Upon being put to the vote Alderman Spark's amendment was carried by a large majority. The Mayor has called a special meeting of the Council for Tuesday next to consider the question.

Electric Railway at Edinburgh.—The Electric and Lighting Committee of the Edinburgh Exhibition are certainly upon the right track in deciding as they have done to encourage the demonstration of electric traction by instituting a useful working electric railway upon a considerable scale within the grounds of the exhibition. For the working of this railway they are now prepared to consider tenders, and an advertisement in another column gives particulars which those who are interested in the development of electric traction would do well to consider. The executive propose themselves to lay down and protect a standard gauge track of 1,000 yards in length on which the contractors will run their own electric railway. This line will have two termini and also two other intermediate stations. It is not intended to be in any way an experimental line, but is to be laid down so as to be of real utility to visitors to the exhibition in getting from one part of the extensive grounds to the other parts, in a similar manner to the little steam railway of the Paris Exhibition, and also to serve as a feeder to the exhibition to and from the Caledonian and North British stations, the tramway terminus, and the landing for the electric launches, so that a really considerable traffic may be confidently looked for. The difficulty in arriving from the various parts of Paris to that exhibition were almost a disgrace, and the crowds of people had either to walk long distances, or wait while crowded 'buses passed, leaving little else than the cabs, who took the occasion to demand extortionate fares. In an exhibition avowedly showing the forefront of electrical invention, a really well-managed electric railway will prove not only a boon to the visitors, but a practical demonstration that is much needed of the ease and convenience of electric traction, now only to be seen in a few lines too far away from usual places of resort. The executive committee will supply power, if required, on certain conditions. The contractors must equip the track with cars, motors, conductors, turnstiles, and other appliances, and agree to pay the executive a proportion of the receipts from the line. It is probable that with proper consideration the line, or a considerable portion of it, might be so arranged as to be of permanent utility to the town of Edinburgh, even after the large traffic which may be anticipated for the duration of the exhibition has ceased.

Crompton's Catalogue.—Messrs. Crompton and Co., Limited, have sent us an advanced copy of their new catalogue, which they are about to issue in a few days, and a very fine volume it makes. It is printed in two editions—one of which may be called an *edition de luxe*. This is priced to the public at half a guinea, and is supplied to their agents and those of the trade who supply their goods. It is bound in a handsome style, and contains, besides woodcuts, a large number of very beautifully printed tinted ink photogravures of their varied dynamos, lamps, and other machinery as actually sent out or in use. The second or ordinary edition contains the same matter, and with the woodcuts, but without the special illustrations, bound in a cheaper style. This is priced at half-a crown, and will be forwarded free to the trade generally on application, not only electrical engineers, but all kindred trades and professions, such as architects, civil engineers, builders, merchants, and exporters. The catalogue contains first a very complete code for ordering or enquiring after machinery by telegraph. The list of Crompton dynamos for incandescent work includes machines from 825 to 66,000 watts (16 lamps up to 1,300), with full details carefully arranged for reference. Arc lighting dynamos are shown for six to 30 arc lamps. Compound-wound dynamos, mounted on Chandler's silent engines, are shown for shiplighting or other situations where space is restricted. Arc lamps, with their accompanying hoisting gear and poles, come next, and ship fittings, with a number of very pretty designs for decorative house lighting, make the electric lighting portion very complete. Large central station switches are fully dealt with, the company's experience with these being very extensive. Crompton's electric crane and hoisting apparatus occupy an important position, and the supply of motors of electric traction and motive power is also dealt with. They have also two specialities of their own in engine fitting, a sight-feed lubricator and a patent straight full-way steam valve, which are highly spoken of by users. The various machinery is all fully illustrated and amply described, in a manner that persons in the colonies or in foreign lands can at once see what they are ordering. For actual extension of electrical business the catalogue is most carefully thought out and arranged, and it should prove extremely useful, more particularly in the direction of heavy electrical engineering work for the supply of principal parts of large installations or central stations.

An International Joule Memorial.—The announcement is made in the form of a circular issued by a committee, of which Sir George Stokes is chairman, Mr. John Evans, treasurer, and Sir Henry Roscoe secretary, that it is proposed to establish an international memorial to the late Dr. J. P. Joule. The circular sets forth that at a meeting of a committee appointed by the council of the Royal Society to set on foot a memorial to the late James Prescott Joule, held on November 30 last, at Burlington House, Sir G. G. Stokes, president of the Royal Society, in the chair, it was unanimously resolved to raise a fund for establishing a memorial of an international character commemorative of the life work of Joule, which should have for its object the encouragement of research in physical science, and which should also have in view the erection of a tablet or bust to his memory in London, a Manchester memorial committee having already taken steps to ensure a suitable monument being erected in his native city. To the scientific and industrial value of Dr. Joule's work it is needless to refer, further than to point to his recognition as the discoverer of the universal law of the conservation of energy, a law, the importance of which can only be compared with that of the laws of gravitation and of chemical combination; and to indicate the material benefits that have already flowed from his discoveries, which, while increasing production, have promoted economy in all the principal industries of mankind, and thus widely extended the beneficent influence of science throughout the world. The committee feel confident that not only will men of science gladly contribute towards a fund to do honour to Joule's memory, and to assist others to follow in his footsteps, but that those also who devote themselves to the practical application of scientific principles will be anxious to aid in the promotion of a fitting memorial of one whose work has exerted so great an influence on industry. Among the gentlemen who have consented to serve on the general committee, most of whom have already promised subscriptions, are: the Duke of Devonshire, the Marquis of Salisbury, the Earl of Derby, Lord Rayleigh, secretary of the Royal Society; Lord Armstrong, Sir G. G. Stokes, M.P., president of the Royal Society (chairman); Sir William Thomson, Sir Lowthian Bell, Sir John Coode, Prof. Reinold, Prof. Osborne Reynolds, Dr. W. J. Russell, Sir F. Abel, C.B.; Prof. W. Grylls Adams, Mr. William Anderson, Prof. H. E. Armstrong, Sir R. S. Ball, Sir Frederick Bramwell, Prof. R. B. Clifton, Prof. M. Foster, secretary of the Royal Society; Dr. Arch. Geikie, foreign secretary of the Royal Society; Mr. R. T. Glazebrook, Mr. John Hopkinson, Mr. Ludwig Mond, Captain Noble, C.B.; Mr. W. H. Preece, Prof. A. W. Rücker, Prof. P. G. Tait, Prof. J. J. Thomson, Prof. Tyndall, Prof. M. Berthelot, Paris; Prof. R. W. Bunsen, Heidelburg; Prof. A. Cornu, Paris; Prof. L. Errera, Brussels; M. H. L. Fizeau, Paris; Prof. H. L. F. von Helmholtz, Berlin; M. Montefiore Levi, Liége; Prof. E. Mascart, Paris; Prof. A. Roiti, Florence; Dr. Werner Siemens, Berlin; M. J. S. Stas, Brussels; and Prof. G. Wiedemann, Leipsic.

BELTS, PULLEYS, AND SHAFTING.

(Concluded from page 48.)

[ERRATA.—In second column, page 46, of our last issue, in the two lines after last numerical example, "driven" in the first line and "driving" in the second line are transposed. It should read: "Revol. first driving × diameter of all driving ÷ diameter of all driven, gives speed of last driven."]

Lubricants.—According to Morin, the friction of a cast-iron shaft on a dry bell-metal bearing is ·2 of the transmitted power, with a wrought-iron shaft it is ·25; but by careful lubrication this can be reduced to ·065 in the one case and ·089 in the other. In using a lubricant, care is required to see that it is properly distributed over the surface and that no waste takes place, or instead of paying for loss of power you will have to pay for waste of oil. Lubricants are tested for (1) adulteration, (2) density, (3) viscosity, (4) gumming, (5) vaporisation and ignition, (6) acidity, (7) coefficient of friction. Of these the minder will trouble little, except, perhaps, for fluidity, as many merchants state the flashing or ignition points, and testing for adulteration—it is not a minder's work. Dipping a bit of blotting paper in the oil will give a good general test of fluidity. When held up to dry, symmetrical drops indicate good fluidity. Lubricating oils should not flash below 250deg. F. (120deg. C). It must be recollected that the suitability of a lubricant depends upon the kind of work, thus a more viscous lubricant may be used with fast speeds, but a more fluid one with slow speeds, but as a rule use the most fluid. There is also the danger of corrosive action. V. Wilson says mineral oils used alone are unsatisfactory lubricants, and suggests a mixture of animal or vegetable with good mineral oil. Tallow, again, is largely used for the lubrication of cylinders, but mineral oil mixed with a small percentage of animal or vegetable is better. The thickest oil that can be got into the cylinders is generally preferred. In gas-engines none but the purest hydro-carbon oils should be used. Some of the gas-engine makers prepare oil specially—*e.g.*, Atkinson for his cycle engines. Don't use vegetable oils. The minder must also remember that waste, rags, sawdust, etc., impregnated with oil is apt to develop spontaneous combustion, and numerous fires have been caused by carelessly accumulating heaps of such waste and rags.

Rope Gearing.—The following notes are taken from the "Mechanical World Pocket Diary," an excellent little book filled with information suited to engineers:

Rope gearing is now very extensively employed in driving mills and factories. The ropes are usually either hemp or cotton, and vary in diameter from $\frac{3}{4}$in. to 2in. The speed of ropes is from 3,000ft. to 7,000ft. per minute, sometimes even greater; about 4,500ft. per minute is a fair average speed. The pulleys are usually of cast iron, with their rims grooved; the sides of the groove are inclined to each other from 37deg. to 45deg., the latter being the most common angle. The rope rests on the sides of the groove, and not on the bottom, and is thus wedged in; the frictional resistance to slipping is consequently very great. The joints are made by splicing, the length of splice being about 15 times the circumference of the rope. The diameter of the pulley should not be less than 30 times the diameter of the rope; the larger the pulley the less injury done to the rope by bending and unbending. The horizontal distance apart between the pulleys may be from 20ft. to 100ft., and the shafting should be so arranged as to allow the ropes to "bag" freely horizontally. They should hang between the pulleys in catenary curves which approximate to parabolas. The lower side should always be the driving side, as the slack side above the arc of contact is thereby increased.

The width of pulley face in inches may be found approximately by multiplying the number of grooves by the pitch in inches, plus from 1 to 2in. for thickness of outer flanges of outside grooves. The largest number of ropes employed in one wheel is probably 38. The rims are usually made in 8, 10, 12, 24, and sometimes 28 segments. Pulleys under 8ft. diameter are generally cast in one piece, and in halves if over 8ft. up to 12ft. diameter; from 13ft. to 20ft. diameter may be made in 6 to 8 segments; from 20ft. to 24ft. diameter 10 segments; and from 24ft. up to 30ft. 12 segments. 32ft. pulleys are often made in 24 segments; large fly rope pulleys from 28ft. to 32ft. diameter are, when extra broad, made with two centres and two sets of arms.

DIAMETER OF ROPES, &c.—TABLE I.

Diameter of rope.	Circumference of rope.	Area of rope.	Net section of hawser-laid ropes.	Weight per foot.	Effective working tension.	H.P. at speed of 1,000ft. per min.	H.P. at speed of 5,000ft. per min.	Smallest diameter of pulley measured at centre of rope.
in.	in.	in.	in.	lb.	lb.			
$\frac{3}{4}$	2·35	·4417	·397	·184	55·5	1·68	8·4	22
1	3·141	·7854	·706	·33	98·8	2·99	14·9	30
$1\frac{1}{4}$	3·927	1·227	1·104	·51	154·5	4·68	23·4	37
$1\frac{1}{2}$	4·712	1·767	1·591	·74	222·7	6·75	33·75	45
$1\frac{5}{8}$	5·105	2·073	1·865	·88	261·0	8·0	44·0	48
$1\frac{3}{4}$	5·497	2·405	2·164	1·0	302·9	9·18	45·9	52
2	6·283	3·141	2·826	1·3	395·0	12·0	60·0	60

The pitch of the pulleys is the distance apart of the grooves from centre to centre. The diameter of the pulley is measured to the centre line of the ropes running round the pulley.

Table II. gives the proportion of grooves for ropes from $\frac{1}{2}$in. diameter to $2\frac{1}{8}$in. diameter.

TABLE II.

A Diameter of rope.	B	C	D	E	F	G	H	I
in.	in.	in.	in.	in.	in.	in.	in.	in.
$\frac{1}{2}$	1	$\frac{3}{4}$	$\frac{13}{16}$	$\frac{5}{16}$	$\frac{1}{2}$	$\frac{3}{16}$	$\frac{5}{16}$	$\frac{1}{4}$
$\frac{5}{8}$	$1\frac{1}{8}$	$\frac{7}{8}$	1	$\frac{3}{8}$	$\frac{5}{8}$	$\frac{7}{32}$	$\frac{3}{8}$	$\frac{1}{4}$
$\frac{3}{4}$	$1\frac{5}{16}$	1	$1\frac{3}{16}$	$\frac{7}{16}$	$\frac{3}{4}$	$\frac{7}{32}$	$\frac{3}{8}$	$\frac{1}{4}$
$\frac{7}{8}$	$1\frac{7}{16}$	$1\frac{1}{8}$	$1\frac{3}{8}$	$\frac{1}{2}$	$\frac{7}{8}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{5}{16}$
1	$1\frac{5}{8}$	$1\frac{1}{4}$	$1\frac{9}{16}$	$\frac{9}{16}$	1	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{5}{16}$
$1\frac{1}{4}$	$1\frac{7}{8}$	$1\frac{9}{16}$	$1\frac{15}{16}$	$\frac{5}{8}$	$1\frac{1}{4}$	$\frac{15}{32}$	$\frac{1}{2}$	$\frac{11}{32}$
$1\frac{1}{2}$	$2\frac{3}{16}$	$1\frac{13}{16}$	$2\frac{1}{4}$	$\frac{3}{4}$	$1\frac{1}{2}$	$\frac{9}{16}$	$\frac{9}{16}$	$\frac{3}{8}$
$1\frac{5}{8}$	$2\frac{5}{16}$	$1\frac{15}{16}$	$2\frac{1}{2}$	$\frac{13}{16}$	$1\frac{5}{8}$	$\frac{5}{8}$	$\frac{5}{8}$	$\frac{3}{8}$
$1\frac{3}{4}$	$2\frac{1}{2}$	$2\frac{1}{16}$	$2\frac{5}{8}$	$\frac{7}{8}$	$1\frac{3}{4}$	$\frac{11}{16}$	$\frac{11}{16}$	$\frac{13}{32}$
2	$2\frac{3}{4}$	$2\frac{5}{16}$	3	1	2	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{7}{16}$
$2\frac{1}{8}$	$2\frac{7}{8}$	$2\frac{7}{16}$	$3\frac{3}{16}$	$1\frac{1}{8}$	$2\frac{1}{4}$	$\frac{13}{16}$	$\frac{13}{16}$	$\frac{15}{32}$

The Horse-Power of Ropes.—P driving force in lb. $= c^2 \times x$. $x = 6$ to 10. $c =$ circumference of rope. $\mathrm{H\,P} = \frac{\mathrm{N\,P\,V}}{33000}$ N = number of ropes on a pulley. V = velocity of rope in feet per minute.

Another rule.—H P = indicated horse-power. A = area of rope in inches. D = diameter of pulley in inches. R = revolutions per minute. $\mathrm{H\,P} = \frac{\mathrm{A} \times \mathrm{D} \times \mathrm{R}}{1000}$.

The life of a rope is from three to five years.

The breaking strength of white or untarred ropes varies from 6,500lb. to 1,150lb. per square inch.

The working strength may be taken at $\frac{1}{8}$ to $\frac{1}{8}$, or from 800lb. to 1,600lb. per square inch; 1,200lb. may be taken as a fair working strength; 140lb. per square inch is common.

The weight of ropes in lbs. per yard is approximately equal to the diameter of the rope in inches squared.

The coefficient of friction of a rope working on a cast-iron pulley is 0·28; when working in a groove it is increased about three times, or from 0·57 to 0·84 for ungreased pulleys. If the pulleys are greased the coefficient is reduced about one-half.

THEORY OF COMPOUNDING DYNAMOS FOR CONSTANT POTENTIAL.*

BY DR. LOUIS BELL.

A short time ago I came across a certain fact that seemed to bear on the theory of compounding dynamos to produce constant potential; I was sufficiently interested in the fact to work it out. It is not complete, for the simple reason that I have not had the opportunity either to revise it or to obtain such experimental confirmation of it as I hope to do later. In general, we can say that the object of compound winding a machine is to avoid extraordinary trouble. If constant potential is desired, it is a possible thing to produce something very like it by a shunt winding alone. It has even been said that a shunt machine with no resistance to speak of in the armature would give a constant potential. That is not quite true, but it is certainly true that a shunt machine with very powerful magnets and very small resistance in the armature will give a potential that is very nearly constant; but to produce such a machine is decidedly difficult. It is not merely a question of designing skill, but sometimes it involves a great deal of trouble, a great deal of added weight and considerable added expense to produce a machine whose field-magnets are so powerful as to completely overpower the armature and produce with simple shunt winding somewhere near a constant potential. As a result compound winding has been devised. It is at the same time to be regarded as a labour-saving device, as a device for improving a shunt machine, designed and made with proper skill and care, and not at all as a device for making a tolerable compound-wound machine out of a bad shunt machine. The result of compound winding of that sort I do not think would be satisfactory from either a practical or theoretical point of view. I shall introduce to-night one machine that evidently was built in that way. One might call it a lazy man's machine—a shunt machine very badly designed and changed to a compound apparently to make up for these deficiencies.

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* Abstract from an address before the Chicago Electric Club, Jan. 6, 1890.

We might start the discussion by asking why a shunt-wound dynamo having powerful field-magnets, and an armature not very powerful relatively to the field-magnets, should not maintain a practically constant potential. The answer which has always been made to that question, and not quite the correct answer, is because the armature has resistance. If, for instance, we have a shunt-wound machine which will give 100 volts on open circuit when worked at its full capacity, the armature will absorb a certain amount of the voltage, so to speak. In other words, a certain amount of voltage is necessary to overcome the resistance of the armature when a powerful current is being passed through it. Therefore a machine which gives 100 volts on open circuit would not give the same amount with a powerful current passing through it, because the armature has an appreciable resistance, and a certain amount of voltage is absorbed there. There will be then a drop in voltage. That amount we can calculate readily. If we have a machine which will give E volts at a certain speed on open circuit, and have an armature with a resistance of R, and then pass the current, C, through it, we will get a drop in voltage which I will call e, equal to R C. And that is the approximate reason why we have to resort to compound winding, or why it is sometimes convenient to do it. Now, the first and natural suggestion is to put on enough series turns to make up for the loss of e volts. Now, that is very simply done indeed, and the result, taking the formula $a=\frac{\mathrm{N}r}{\mathrm{R}}$, would be that A, the number of series turns required to do that work, would produce e volts, and bring the voltage up to the point where we started.

Now, if that were all that were necessary, I should not be reading this paper now. Compound winding would have been worked for all it is worth, and that would be the end of it. Unfortunately, that is not enough, and for this reason: The voltage at the terminals has dropped on account of the absorption of voltage in the armature. Now, if we are to get 100 volts at the terminals, we must produce in the machine more than that, because we are using up a certain amount, e, in the armature. In order to accomplish that, the induction through the magnets must necessarily be increased, and the other factors remain constant; that is, the speed and number of wires in the armature. I am going to use the term "magnetic resistance." I am aware that it is a term that is not in good theoretical standing. I see that Mr. Fleming, in his recent book, has used it, and I am going to make bold to use that term, because it is convenient. We then meet the difficulty that this number of series turns, A, will not do the work, because by adding the necessary induction, we increase the magnetic resistance a certain amount. Suppose we call the magnetic resistance of the machine at the start q; call the resistance at full load, the resistance when we put on the maximum induction that we are going to use, $q\,x$. The magnetic resistance then is increased in the ratio of $\frac{q\,x}{q}$. Consequently, in order that the series turns added should produce e volts to make up for that drop in voltage, we must wind on not A series turns, but a number rather larger than a, to compensate for the fact that the magnets have increased in magnetic resistance. In other words, it would be in the ratio of $\frac{q\,x}{q}$. That is the point where S. P. Thompson, in his well-known book, dropped the subject, and that is the point where, so far as I know, nearly everybody else dropped it. That is very pretty, so far as it goes, and it is perfectly correct so far as it goes, and that is all. Anybody who attempts to build a compound-wound machine according to that formula will find himself very sad when he gets through, because he will not get a constant potential by any such machine. The next question is, why? It is perfectly evident that if that does not give the result there is some good and sufficient reason for it; that there is something we have forgotten, and that that something probably, judging from the results of trying to use the formulæ, is a very important something. The first thing is this: We have increased, by adding series turns, the magnetic resistance in the ratio of $q\ x$ to q, and that applies to the shunt windings as it does to the few series turns that we have added, for by adding these series turns and increasing the induction we have increased the magnetic resistance. Then surely the number of shunt windings which produce E volts, when the magnetic resistance is q, will not produce it when the magnetic resistance is $q\,x$. We must add, then, either more shunt turns or an equivalent in series turns. And that is one of the important things which has been neglected in the question of compound winding. It is not very difficult to compute that amount. The shunt ampere turns sufficient to produce e when the resistance is q of course will not produce it when the resistance is $q\,x$; therefore, we must add enough series turns to bring the induction up to its proper value.

If the iron is not nearly saturated—in other words, if the machine were properly designed in the first place from a magnetic point of view—that quantity will not be a large one. So that, so far as things considered up to this point are concerned, we should have properly the e volts with which we started out, the drop in the armature having been counteracted. But, unfortunately, another term has been neglected in the question, and one that is still more important. I think every man who has built a compound-wound machine will be able to have tolerable clear idea of what that term is, although the value of it has not been taken into account properly. It is a term that is caused by the demagnetising effect of the armature current. The armature is cross-magnetised and the field is disturbed by by it, and as soon as the brushes are given a lead, to get them to a point where they will not spark, the effect of the armature begins to make trouble and demagnetises the field-magnets. There is a certain contrary magnetomotive force in the armature, owing to the fact that it is running with lead, and has to be run with a lead on account of the disturbance between the field and the pole-pieces. The demagnetising effect upon the armature may rise to such a considerable amount as to cause serious trouble, particularly if the machine is a high potential machine, and there are very many turns in the armature, or if the machine has insufficient iron in the field-magnets the same result will follow. That amount has been and is very readily worked out in terms of the number of windings on the armature. Its effect is quite large in some cases, so that instead of saying, as one customarily does, that to build a shunt machine to give a constant potential you should have little or no resistance in the armature, we should also have to say in addition that it should not have any convolutions on the armature to speak of, or it will give the cross-magnetising effect. It should be noted right there that everybody knows who designs machines that the sparking trouble that compels one to shift the position of the brushes to get them to a non-sparking point, is very considerably affected by the shape of the horns of the pole-piece. Sometimes a little tact in changing the shape of the ends of the pole-pieces will enable one to run with a great deal less lead, and get a very much more workable machine. But to return to the demagnetising effect of the armature. That amount has been worked out by Hopkinson, although it is not quite compound winding. It was worked out by him in that admirable paper, published in 1886, which I was about to say contains the sum and substance of the theory of the dynamo; it is a paper which has not been read as much as it ought to be. He worked out the cross magnetising effect of the armature, the demagnetising effect, and found it to be the following: The formula is $4\pi C \frac{m\,2l}{2\pi} = 4\,lm\,C$. In other words, he found the magnetised effect in magnetic units depended upon the angle of lead of current, and the number of convolutions in the magnet. Now, having this demagnetised effect of the armature, all we have to do to counteract it is to reduce it to its corresponding number of series turns, and that comes out very simply. Suppose we call C the number of series turns necessary on that account; we have C equals the simple quantity $C = m\frac{l}{\pi}$. In other words, the number of series turns which will have to be added to counteract the demagnetising effect of the armature equals the number of turns on the armature, divided by the quantity $\frac{l}{\pi}$ where l is the angle of lead.

Now then we have those three factors which go to make up the series turns necessary to give a constant potential machine. The first one, the one which has been known for a good while due to the fact that the armature has a resistance. The second one, due to the fact that the magnetic resistance of the machine increases as one computes the series turns to take care of the first turn. And finally, still more series turns must be added to counteract the demagnetising effect of the armature. And they come out in respectively simple forms. The only trouble is this quantity, $\frac{qx}{q}$. We do not always know what qx is, although we ought to know very nearly what q is if the machine has been carefully designed in the start. But it is quite easy to get an approximate idea of qx from almost any of the published curves of magnetisation. Those in Hopkinson's paper are perhaps the handiest to work with that I know of. If anyone knows anything about the iron that is used in building a machine he can arrive at a fairly good idea of qx. It is a quantity that is quite obtainable. I think that these three terms include all the terms which are of sufficient size to be met with in actual dynamo building. Theoretically, they are not all that would have to be taken into account, and I have omitted, in the first place, all terms involving the square and higher powers of the ratio, because they are quite small; in the next place, all terms involving the differential of that ratio; and, finally, the periodic terms which involve the self-induction of sections of the armature and things of that kind. They are very small, I think, compared with either of these three terms, and so small that they need not cause very much trouble in practice. One thing more, so far as these terms are concerned, and the work is complete. These series turns should be wound on the magnet. Consequently, the number of series turns, whatever it is, deduced in this way, would have to be multiplied by the coefficient of leakage of the machine, whatever that may be. That coefficient is very seldom as low as 1·25 and not very often as high as 1·9. So we will have to multiply the number of series windings derived in this way from these three terms by that coefficient, whatever it may be, to get the total number necessary. There is quite a wide variation in the value of leakage, and, of course, any form of magnetic frame that we are tolerably well acquainted with, we can make a very close guess indeed as to the actual value of this coefficient.

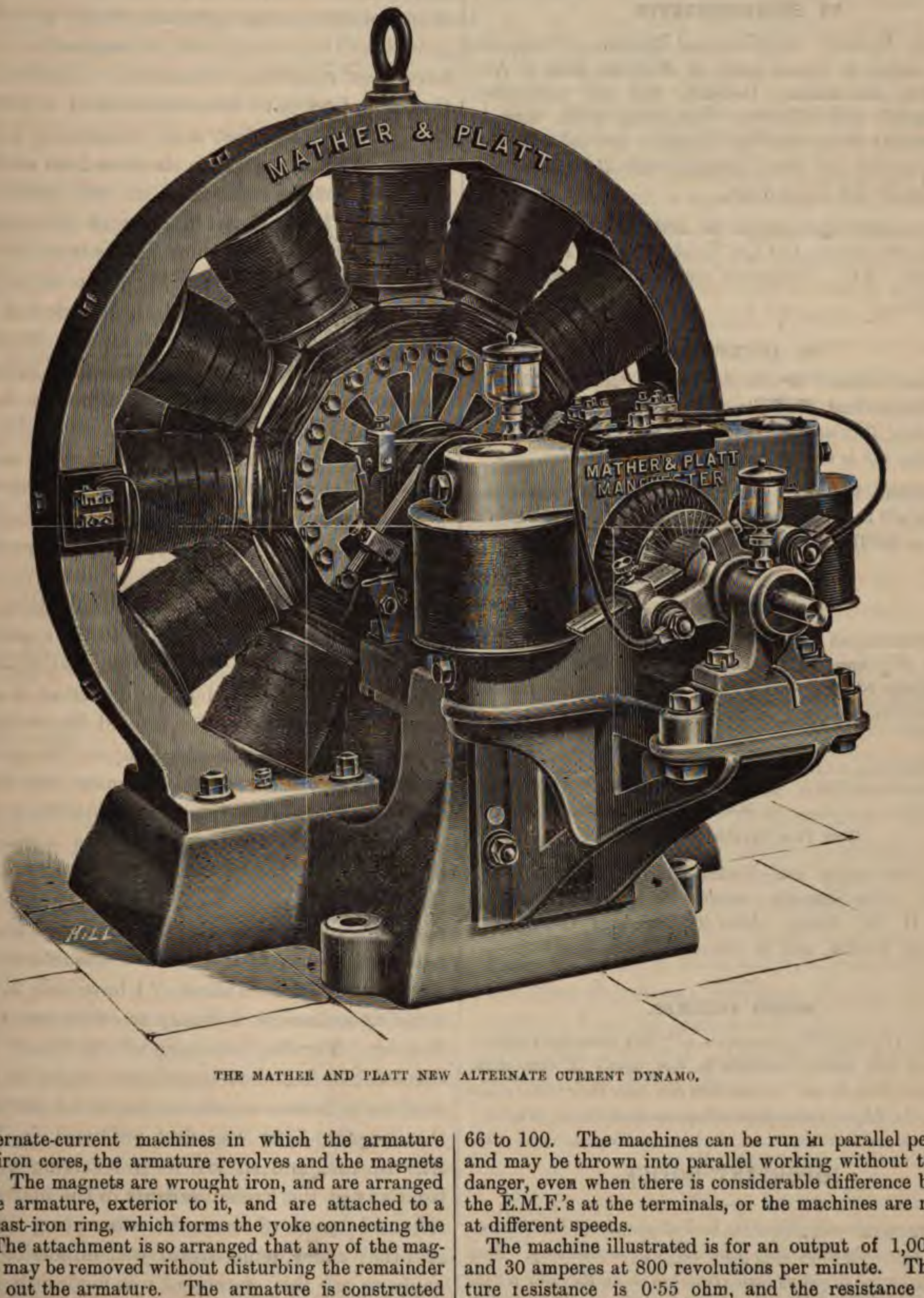
I added these two terms, B and C, and looked to find specifications in some compound dynamo for the sake of applying this, and seeing whether it actually gave the proper number of series turns to be applied. I was not very lucky in that search. I had little time in which to look, only a couple of days, and I did not find very much, and I am compelled to use as an illustration a machine which shows a necessity for the corrections more than anything else. It is the machine described by Thomson. It is a four-pole machine with a Gramme armature. The armature contains 320 turns with a resistance of ·025 ohm. The total resistance of the series turns was ·005 ohm, making ·03 ohm the total resistance. The dimensions of the machine are partly given, but the machine was built with very much too little iron. The iron was very much over-saturated. In fact, the amount of iron was so small as to be very objectionable, the over saturation being very severe. The details of the machine were not given as perfectly as I would like to have them; I had to make a guess for the ratio. The guess I made for that was $\frac{qx}{q} = 1{\cdot}3$. The leakage I take is 1·6, which was not an excessive amount, I think, for a four-pole machine built on these lines. It is rather small, if anything, considering the character of the machine. Finally, the leakage I took as $l = \frac{1}{10}\pi$, which I think is not a large lead for a saturated machine; a machine where there is too little iron and with quite a powerful armature.

These three quantities I judged, as far as I could, without working them through to see where they would lead me. Having taken those, I proceeded to put them into these various formulæ with the resistances given, and the number of shunt terms given, which was 352, as I mentioned before, on each of the four poles of the magnet. The result I found was this: Taking these terms one by one $A = 8$ turns, $B = 20$ turns, showing that this factor which has been completely neglected in most work of this kind was, in this case, more than twice the quantity which Thompson would give for the full number of series turns necessary for compound. And then working out the armature turn, $C = 32$, it makes a still further increase. In fact, the amount owing to the armature alone was four times the number given by this old standby formula. Then multiply the whole by n, the coefficient of leakage of the machine, we get 96 series turns as necessary to compound that particular machine. Having worked that out I turned back to the description of the machine, 96 was the series turns on that machine. In other words, I happened—I say happened, because I did not know exactly what those were—to get precisely the number of series turns that were required as found in practice to compound that machine. Now, I do not know whether it was well compounded or badly. Judging from the general design, I should say that it was not compounded very well. At all events it is quite clear that these three terms give a close approximation to the actual number of turns found to be necessary. If that is true in a machine so thoroughly saturated, a machine with altogether too little iron in it, and a machine where the voltage at full load, without compounding, must be barely over half the normal voltage, which is 65; if it works properly in a machine of that kind, so as to give approximately the number of turns required to compound it, it certainly ought to do so where the number of volts to be accounted for is one-tenth of the total number produced. I have not been able to get any other machine to which I could apply it, but, from the result of that, I am convinced that it is a fairly good approximation to the number of terms actually required in practice.

In closing I would reiterate again what I said at the start, that I do not think the compound machine ought to be abused in the way it was when the machine that gave these results was designed. It is too much to ask a machine to do, to scrimp it on iron, proportion it badly, and then expect it to give constant voltage; it simply will not do it.

I will say that these formulæ will compound the machine correctly, I think, when the voltage due to the shunt turn is E. Consequently, it will compound correctly when the machine is run at such a speed that the shunt turns alone will give E volts on open circuit, and that will be the speed for compounding, and the speed at which these formulæ represent, I think, nearly the proper amount of series turns. Of course, if the machine is run at any other speed—in other words, if the shunt windings give more or less than E volts—the machine cannot be expected to compound. It would not compound, and everybody knows very well that a compound machine is sensitive to changes of speed.

THE MATHER AND PLATT ALTERNATE CURRENT DYNAMO.



THE MATHER AND PLATT NEW ALTERNATE CURRENT DYNAMO.

Messrs. Mather and Platt, of the Salford Iron Works, Manchester, are now manufacturing an alternate-current dynamo which embodies several new features, and has given very satisfactory results in practice. As is the case with most alternate-current machines in which the armature contains iron cores, the armature revolves and the magnets are fixed. The magnets are wrought iron, and are arranged round the armature, exterior to it, and are attached to a massive cast-iron ring, which forms the yoke connecting the limbs. The attachment is so arranged that any of the magnet cores may be removed without disturbing the remainder or taking out the armature. The armature is constructed of two plates or discs keyed on to the shaft, between which the armature-coils are held by bolts. As with the magnets, any section of the armature can be removed without disturbing the remainder. Apertures in the discs allow free ventilation in the interior of the armature cores. The magnets are excited by a Mather and Platt's "Manchester" dynamo, which is carried on a bracket bolted to the bed-plate of the alternator, the armature shafts being coupled direct.

The whole arrangement is exceedingly compact, occupying little floor space.

The machines are manufactured under the patents of Dr. John Hopkinson and Dr. Edward Hopkinson, and are made in several standard sizes up to 100 Board of Trade units.

For working with transformers they are constructed either for 1,000 or 2,000 volts, and from 8,000 to 12,000 alternations per minute, or with a "periodicity" of from 66 to 100. The machines can be run in parallel perfectly, and may be thrown into parallel working without the least danger, even when there is considerable difference between the E.M.F.'s at the terminals, or the machines are running at different speeds.

The machine illustrated is for an output of 1,000 volts and 30 amperes at 800 revolutions per minute. The armature resistance is 0·55 ohm, and the resistance of the magnets two ohms. When working with full load the current through the magnet-coils is 21 amperes, showing an electrical efficiency of over 95 per cent.

Messrs. Mather and Platt have already constructed several of these machines for central station work, and have a number now in course of construction.

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GOVERNMENTS AND PATRONAGE.

It is the cry of every inventor who produces what he believes to be an advance upon previous industrial applications that the Government ought to take up his invention, pay him a handsome royalty, and show the world how valuable is the outcome of his brains. Telegraphists outside the Post Office say that invention has ceased, that the Government monopoly is against progress, that if the telegraphs had been in the hands of private adventurers there is no knowing what apparatus would have been invented ere this—at any rate, in imagination, it would have been something wonderful. Telephonists say that litigation gave the Government a favourable verdict, and from that time telephonic invention ceased. Officials, who are about as keen as business men are usually made, say, on the contrary, telegraphy in England is in front of all telegraphic administration in the world. The work is heavier, it is better done, and the apparatus is being continually modified, developed, and perfected. They also say telephony in the hands of the State would be in as satisfactory a condition as is telegraphy. And so recrimination goes on. There is, however, one of the greatest applications of electricity that is uncontrolled by the Government, and its action towards that application gives us some inkling as to whether Governments are unobservant, conservative, and hard to move. We refer to electricity as applied to lighting.

History tells us that the introduction of the electric light was originally due to the requirements of lighthouses. The Trinity Corporation was perhaps the prime mover, but the Board of Trade had to sanction expenditure. We all know that such expenditure was sanctioned upon the favourable report of Prof. Faraday. Of course the Board of Trade took its own time in the matter, and would not be hurried. The Society of Arts is generally in the forefront of any movement, and its *Transactions* show some of the credit that must be given to the Government through the Trinity House for an enlightened policy. Also its *Transactions* contain these memorable sentences: "I have only to remark that this invention, if it may be called one, is purely English. Faraday commenced it when he discovered the fact that magnetism might be made to produce or induce an electric current; and although the magneto-light was first produced in Paris, it was by me, and so far from receiving assistance from any of the French *savants* in the matter, I was ridiculed by all of them for attempting what they said they could demonstrate was impossible." We ought to say this statement was vigorously objected to by the Abbé Moigno, but a careful examination of the objections rather convinces one that the Englishman was right. The speaker was Mr. F. H. Holmes, and it seems that the true history of an electric light from a machine is something as follows: In 1853 some magneto-electric machines were erected in Paris for the decomposition of water. The company under whose auspices the experiments were made came to grief, and Mr. Holmes was struck with the thought that light could be got by means of these machines. He tried with a Duboscq lamp and succeeded, though not very satisfactorily. The machines were not adapted for such work. Subsequently, in 1857, Mr. Holmes applied to the Trinity Board, and experiments were authorised first at Blackwall, then at the South Foreland, and on the 8th December, 1857, the experiments at the lighthouse was commenced. These experiments were continued off and on for some time, till the decision was made to fit up Dungeness with the new illuminant. In February, 1862, the light was started at Dungeness, but was soon stopped, and not till June 6th, 1862, did it commence to shine as a permanency. From that time to this the electric light has increased and multiplied in lighthouses. This development has certainly been due to the fostering care of Governments, although it may be said the light is so admirably adapted in certain positions for such work that they could not help themselves. Certainly the light, as applied to lighthouses, is not adapted for general illumination, and not till better machines and better lamps were designed had the Government any opportunity of showing its interest in electric lighting. As soon as these came into the market, with the incandescent lamps fairly satisfactory, it was seen that such lighting was admirably adapted for ship lighting, and, as the result, it will be found that the Admiralty was among the first to recognise the fact, and has been the largest purchaser and user of the modern dynamo and its accessories. Several firms have pulled successfully through a most disheartening and dismal time solely through Government purchases. Further, the Post Office authorities rightly judged that the new illuminant was better adapted than gas for some of their largest and busiest centres, the result being that the electric light was installed at several of their busiest centres with great satisfaction. Other Government departments have likewise patronised electricity, and the names of some of the Royal Engineers are almost as familiar to electricians as they are to other members of the service. One other action of a Government department, and we have done enough to show that in this particular industry patronage has not been withheld. Almost among the first suggestions for the use of motors was that they might be utilised in gunnery operations—training of the guns, etc.—and it is pretty generally known that Messrs. Maxim, Massey, and Crompton carried out experiments for the Government in this direction. We believe that the initiation was due to Mr. Maxim, who was directly assisted by Mr. Massey, while Mr. Crompton constructed the apparatus. Whether the Maxim gun took that inventor's attention into another channel, or whatever the cause, we have heard nothing as to the success or the non-success of motors for this particular work for a long time. Still, the immediate object we have in hand is served by showing that the Government departments are by no means disposed to pooh-pooh an invention which can be shown to them to give promise of good results. As we have said, the electric lighting industry was practically kept alive for a considerable period by the orders for ship lighting, and of these orders the great bulk were placed by the Government. The large companies followed suit, and now we should imagine it is the exception, and not the rule, for a new steamer to be lighted by any other means than electricity. Public departments seem made almost for the purpose of being kicked by everybody. When anyone has a grievance his game is some particular department. Electrical engineers can examine the record for themselves, and may assume that what holds good in this particular instance probably holds good for other things, hence may arrive at a consoling conclusion that, after all, Government officials may not be so bad as they are painted. Doubtlessly a good deal of red tapeism is the order of the day, and it may take him months' correspondence and a thousand letters to get a level mended, but certainly the adoption and purchase of dynamos is not surrounded by these difficulties. In this general account of Government patronage, we might have mentioned the large use made of search light apparatus, a use which alone would give employment to a goodly number of hands, for, undoubtedly, all the new ships now building and to be built will be freely equipped with such apparatus. If we were asked in what special direction Government action, as regards the industry, shows signs of too much red tape, we should feel inclined to say in the information it gives. No doubt elaborate series of experiments have been made, and reports sent in, but these reports are kept from the lay reader, and, perhaps, from the professional; put into the pigeonholes and forgotten. Occasionally, a few results leak out, but that is all.

A SUGGESTION.

As the hand of time is so rapidly thinning the ranks of the pioneers in submarine telegraphy, is it not possible to make an effort to obtain some account, from those who remain among us, of their recollections of their early days? How many persons are now living who can say like Mr. Willoughby Smith, "Yes, I crossed the Channel with the first experimental cable"? Was this the cable that lived and died the same day, a specimen of which was shown to us by Mr. Whitehouse at Brighton two or three years ago, and of which other specimens exist? One of these specimens should somehow or another come into the hands of the Institute. Accurate and authentic knowledge could be obtained only from the few who were actually occupied in these early telegraphic endeavours, and we appeal to their spirit of desire for the progress of humanity, and to their feelings of pride in the achievements of science, to leave for the use of future historians of science the account of the actual facts which then occurred, and of the part which they, the pioneers of cable work, took in that time of grand endeavours, of eager and ceaseless work, of heart-breaking failures, and of final and world-wide success. Those who so nobly worked in the cause of science have much to say that will be of absorbing interest, not only to electricians, but to the world at large.

DATA AND PLOTS OF VARIOUS INCANDESCENT LAMPS TOGETHER WITH AN IMPROVED METHOD OF TESTING.*

BY WM. L. PUFFER.

Since the appearance of the report of the Franklin Institute on incandescent lamps in 1885, there have been no published measurements either of the efficiency or of the distribution of light about the best-known lamps now in the market. But the market lamps of to-day are much better than those of 1885, so much so, in fact, that the Franklin Institute data, although very valuable as showing the state of the art in 1885, are of no especial value for use with the lamps now manufactured.

The following data and curves have been calculated and plotted from the observations made by Messrs. Walter G. Whitmore and Edwin R. Pearson, class of 1887, Massachusetts Institute of Technology, who took as the subject of their graduating thesis "A Study of the Efficiency of Incandescent Lamps." The method used is substantially like that of the Franklin Institute, but I have changed and improved the method of plotting so that the five plots tell the distribution of light, shape of filament and its position in regard to photometer, etc. This method of testing lamps is in regular use in the laboratory with very satisfactory results.

The standard of light used is a Methven screen which has been standardised by comparison with many standard candles at different times and by different observers, and also with a Harcourt standard burner. The mean of a large number of observations agrees so closely with the maker's value of two candles that this is assumed to be right within the limits of error of the photometer, and no correction is used.

The photometer is a modified Bunsen, 100in. long, graduated into inches and tenths by a dividing engine, and having also a scale of "ratios" which when multiplied by the candle-power of the standard give candle-powers directly. Both the standard burner and the lamp under test are thoroughly screened so that little, if any, diffused light reaches the eye of the observer. A key near the observer's hand and a lamp overhead furnish light when needed for reading.

The lampholder is quite different from that used by the Franklin Institute, and will hold any of the lamps now in the market without danger of straining. The socket with lamp under test is screwed on the end of a brass rod, which is free to slide or rotate in a sleeve fixed in the centre of and perpendicular to a disc of brass. Set screws are provided for clamping the rod in the sleeve. The disc is arranged on the bottom of a U-shaped strap in such a position that it can be turned while the rod always remains parallel to the sides of the U and in the same plane. The disc has notches every 5deg., and the strap carries a locking pawl, which also serves as an index.

The U-shaped strap is pivoted near the top in a frame so as to have rotation about a horizontal axis; it also has a notched disc, and the frame a pawl and index. One arm of the U is longer than the other, and carries a movable counterweight.

This apparatus is set with the horizontal axis perpendicular to the line of the photometer and on a level with the centre of the greased disc; the vertical circle being adjusted to read 0deg. when the lamp stands vertical with the socket underneath, then the horizontal disc is placed at 0deg. and the rod carrying the lamp moved till the plane of the shanks is perpendicular to the line of the photometer and the horizontal axis cuts the filament midway of its length.

This position of the lamp is called the "standard position," and the photometer reading for this position, the "standard reading." By means of the horizontal circle, any desired degree of longitude can be instantly turned towards the photometer and by the vertical circle any degree of latitude. Flexible wires connected directly to the socket are used for current leads, and another set is used for measuring the potential at the lamp terminals. It is assumed that the socket and the lamp terminals will be of the same potential, except with very low-resistance lamps, or with lamps requiring a large current.

Electrical measurements were made by a set of carefully calibrated Thomson's current and potential galvanometers, placed in a room free from magnetic disturbances, where the value of the earth's component had been determined. As the current taken by the potential galvanometer bears a very sensible ratio to that in the lamp, the instrument is always kept in circuit and a correction is made for the current passing through it. An adjustable resistance in the lamp circuit enabled the observer to keep the potential at the right amount. The potential galvanometer used was adjusted for Rayleigh volts, and as the difference between this and Legal volts is nearly within the limits of accuracy of the instrument no correction for reduction to the latter was made. It was assumed that the voltage marked on the lamps was in Legal volts, and that if the lamp changed its resistance while under test the volts must remain constant and the current and candle-power allowed to vary. If any lamps were marked in terms of the B. A. volts, then they were tested at too high a voltage.

When the lamp had been placed in the "standard position" and the potential adjusted, candle-power readings were taken at 65 different positions; the value used for each position being the mean of three or four settings of the disc according to the method used by the observer.

The standard direction to which all others are referred, is a line perpendicular to the plane of the shanks of the filament and lying in the equator of the lamp. By equator is understood the line cut upon the glass globe of the lamp, when upright, by a horizontal plane half way up the filament. *Zero point or* 0deg. is the starting point for measuring the angular rotation of the lamp,and is at the intersection of the standard direction and the equator.

Horizontal distribution is measured by candle-power readings at each 30deg. around the equator beginning and ending with 0deg. or the "standard direction." Of these 13 c.p. readings, the first and last should, of course, check.

Mean horizontal candle-power is the mean of the first 12 of these readings, the check reading being omitted.

Vertical distribution is measured on each of four complete meridians—*i.e.*, those of 0deg., 45deg. 90deg., 135deg. on the equator. On each of these four circles candle-power readings are taken at every 30deg. (of latitude), beginning and ending with 0deg., thus giving 13 readings, the first and last of which should check.

Standard reading is the mean of all readings in the direction of the zero point ("standard position"). It is an arbitrary position selected for convenience. By it and the "reduction factors" the candle-power (spherical or hori-

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*From the *Electrical Engineer* (New York).

RESULTS CALCULATED FROM THE OBSERVATIONS OF MESSRS. WHITMORE AND PEARSON, CLASS OF '87, BY WM. L. PUFFER.

Lamp—1887-8.	Mean standard reading.	Mean spherical c.p.	Spheric'l reduction factor.	Mean horizontal c.p.	Horiz. reduction factor.	Spher. ÷ horizontal.	Volts.	Amperes.	Watts.	Watts per spherical c.p.	Watts per hor. c.p.	Lamps per e.h.p.	Mean spherical can. per e.h.p.	Mean hor. can. per e.h.p.
Weston. 70 volt. 16 c.p.	16·63	14·25	0·857	15·13	0·909	0·942	69·96	1·021	71·43	5·01	4·72	10·4	149·	158·
Weston. 110 volt. 16 c.p.........	8·97	10·96	1·222	13·37	1·491	0·820	110·1	0·530	58·36	5·32	4·36	12·8	140·	171·
Thomson-Houston. 52·6 volt. 20 c.p.	21·00	16·82	0·801	20·68	0·985	0·813	52·61	1·250	65·76	3·91	3·18	11 3	191·	235·
Thomson-Houston. 75 volt. 16 c.p.	16·00	13·31	0·832	16·18	1·011	0·823	74·98	0·705	52·87	3·97	3·27	14·1	188·	228·
Thomson-Houston. 110 volt. 16 c.p........	13·00	10·50	0·808	12·86	0·990	0·816	100·1	0·472	51·96	4·95	4·04	14·4	151·	185·
Edison. 101 volt. 10 c.p...... ..	10·50	8·25	0·786	10·38	0·987	0·795	100·9	0·512	51·65	6·26	4·98	14·4	119·	150·
Edison. 101 volt. 16 c p.........	13·00	13·25	1·020	16·46	1·27	0·805	100·9	0·789	79·58	6·00	4·84	9·4	124·	154·
Edison. 101 volt. 32 c.p.........	26·53	28·59	1·078	34·21	1·290	0·836	100·9	1·295	130·7	4·57	3·82	5·7	163·	195·
Swan. 36 volt. 8 c.p.	8·09	6·61	0·817	7·76	0·959	0·852	35·96	0·786	28·26	4·27	3·64	26·4	175·	205·
Swan. 38 volt, 16 c.p.	13·10	10·57	0·807	12·25	0·937	0·863	38·05	1·300	49·65	4·70	4·05	15·0	179·	203·
Swan. 46 volt. 8 c.p............	7·39	5·89	0·797	6·70	0·907	0·879	45·99	0·534	24·56	4·17	3·67	30·4	210·	244·
Swan. 46 volt. 16 c.p.	15·54	14·38	0·925	16·73	1·077	0·859	45·99	1·113	51·18	3·56	3·06	14·6	141·	177·
Swan. 92 volt. 10 c.p.	8·88	7·17	0·807	9·03	1·027	0·794	91·98	0·413	38·00	5·30	4·21	19·6	157·	191·
Swan. 92 volt. 16 c.p.	15·30	11·49	0·751	14·00	0·915	0·821	91·98	0·594	54·64	4·76	3·90	13·7	185·	217·
Swan. 92 volt. 32 c.p.	33·57	27·74	0·826	32·48	0·968	0·854	91·98	1·215	111·8	4·03	3·44	6·7	159·	184·

zontal) may be determined under any given potential or current at any subsequent time by one reading. Great care should be taken in placing a lamp in this position, because in some lamps a very slight error would make a very considerable difference in the candle-power, and, of course, in the "factors." When a number of tests are to be made on any one type of lamp, it is preferable to select a point on the horizontal circle in that part of the curve where the rate of change of candle-power is very small, and so avoid error due to hasty or imperfect setting of the lamp for the standard reading.

Mean spherical candle-power is computed from 38 readings selected from those described, with the aim of obtaining the average intensity of light in all directions. These readings are as follows (in degrees) :

Mean of 4 north pole readings (long. 0, 45, 90, 135)							counts	1
Longitude	0,	Latitude	60,	120,	240,	300,	giving	4
,,	90,	,,	60,	120,	240,	300,	,,	4
,,	0,	,,	30,	150,	210,	330,	,,	4
,,	45,	,,	30,	150,	210,	330,	,,	4
,,	90,	,,	30,	150,	210,	330,	,,	4
,,	135,	,,	30,	150,	210,	330,	,,	4
Equator, 12 readings (or mean horizontal × 12)							counts	12
South pole reading assumed zero and counts ...						...	...	1
							Total	38

The values for these positions are selected, added and divided by 38.

Horizontal reduction factor is the mean horizontal candle-power divided by the standard reading.

Spherical reduction factor is the mean spherical candle-power divided by the standard reading.

The mean spherical candle-power divided by the mean horizontal candle-power gives a very useful factor which is not so much affected as the two above by a slight error in setting the lamp in the exact standard position. Inspection of the curve for the 70-volt Weston lamp will show that a very slight error would materially change both the horizontal and the spherical reduction factors, but would not alter the ratio of the two. Obviously the product of the standard reading taken at any time, and the reduction factors will give the horizontal or spherical candle-power without any other measurements.

The method of plotting the results of a test on a lamp is thought to be an improvement on the Franklin Institute method, and is designed to show at a glance—

1. The distribution of light in five great circles. 2. The relative position of the lamp filament to the photometer at the zero of each circle. 3. The appearance of the filament as seen from the photometer disc at the zero of each circle. 4. The rated candle-power. 5. The mean spherical candle-power. 6. The mean horizontal candle-power. 7. A table of data.

For example, take the 70-volt Weston lamp. This lamp has a zig-zag filament of rectangular section twisted when mounted, which gives a very characteristic set of distribution curves.

On the horizontal plot we see the photometer bar represented by the black line on the left, and in the centre is the horizontal projection of the filament at the zero position, "with the plane of the shanks perpendicular to the line of the photometer bar," and also a drawing of the filament as seen from the photometer disc at the zero of the circle. The curve shows that the light is greatest at about 150deg. and 330deg., and weakest at about 60deg. and 240deg. ; now, according to the Philadelphia method, we could not tell why this is so, but a glance at the projected filament (and also the pictures of the filament seen at 0deg., 45deg., 90deg., 135deg.) shows that in one case the sides and in the other the edges of the corrugations correspond with the highest and lowest photometer readings. This plot also shows that the mean spherical candle-power is nearly equal to the mean horizontal, but that neither are up to the rating of 16 c.p. under any reasonable assumption that can be made as to the meaning of that term. The observed candle-powers are indicated by the figures written near the intersection of the curve and the radii drawn 30deg. apart.

The next plot shows the distribution of light in a vertical plane passing through the zero of the horizontal circle. As before, the horizontal projection of the filament is seen in its position relative to the photometer bar at the zero of the circle, and a drawing of the filament as seen from the photometer at the zero position.

The next plot shows the distribution in a vertical plane passing through 45deg. on the horizontal circle. The projection of the filament shows that the divided plate and lamp was turned 45deg. right-handedly, thus bringing the 45deg. position on the horizontal plot towards the photometer. The diminished amount of light is due, as indicated by the sketch of the filament, to the presentation of the edges of the carbon to the photometer. The next two plots are taken in a similar way at 90deg. and 135deg. respectively on the horizontal circle.

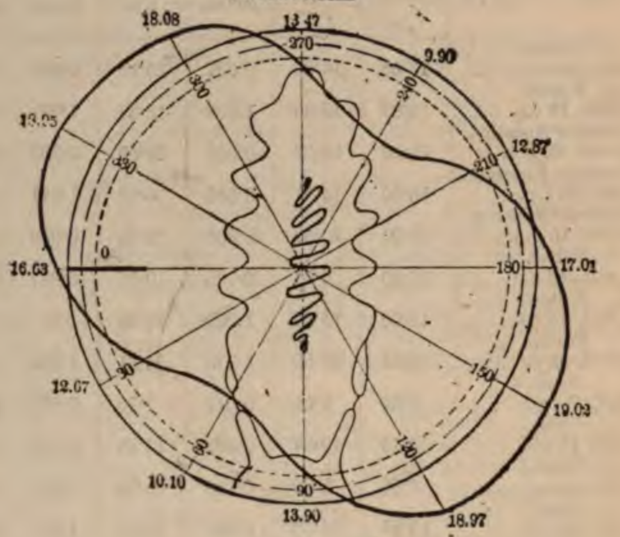
The pictures of the filament were obtained by holding the lamp behind a plate of glass and before a bright lamp

DATA AND PLOTS OF VARIOUS INCANDESCENT LAMPS.—PLATE I.

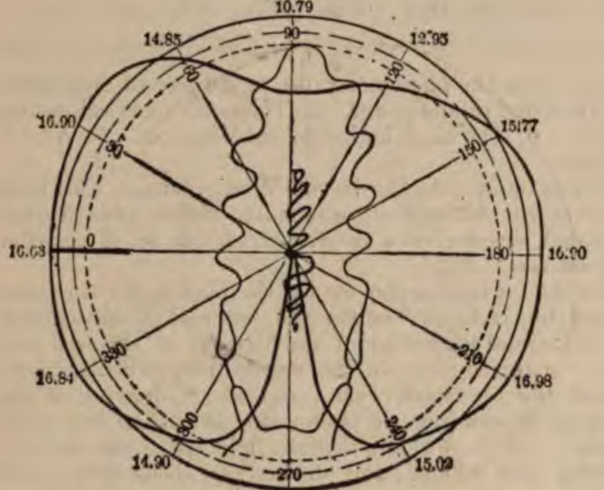
Lamp.—Weston, 70 volt. 16 c.p.
Mean standard reading = 16.63.
Mean spherical c.p. = 14.25.
Spherical reduction factor = 0.857.
Mean horizontal c.p. = 15.13.
Horizontal reduction factor = 0.909.
Mean spherical c.p. ÷ mean horizontal c.p. = 0.942.
Volts. = 69.96.
Amperes = 1.021.
Watts = 71.43.
Watts per mean spherical c.p. = 5.01.
Watts per mean horizontal c.p. = 4.72.
Rated c.p. = full circle.
Mean spherical c.p. = dotted circle.
Mean horizontal c.p. = dashed circle.
Section of filament = ▬
Scale, 10 c.p. per inch. W.L.P.

Full circle reduced from 3.2″ to 2.5″ in engraving.

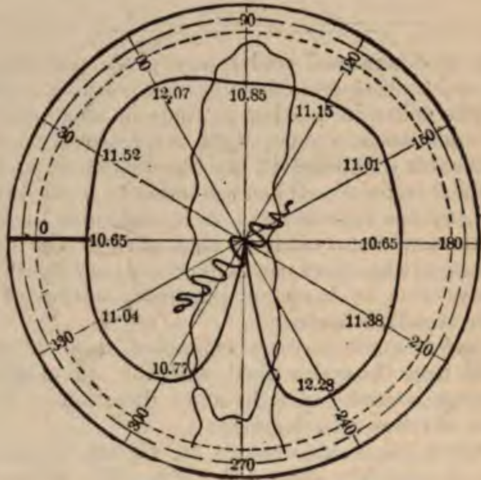
HORIZONTAL



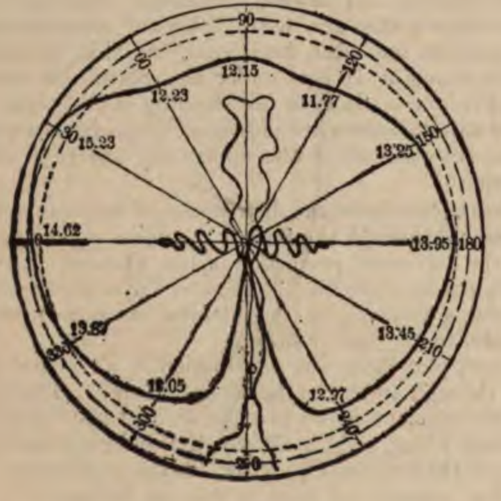
VERTICAL 0°



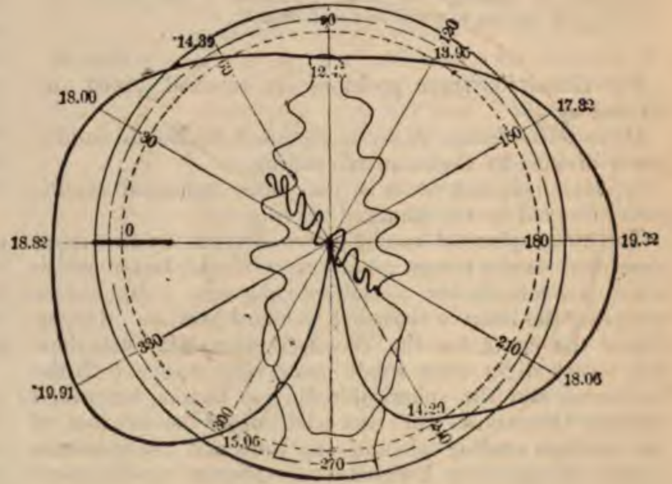
VERTICAL 45°



VERTICAL 90°



VERTICAL 135°



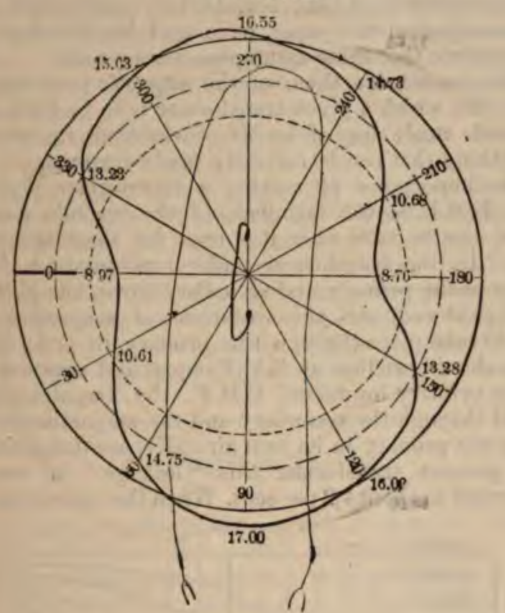
and tracing the shadow of the filament. The scale of plotting is, unless otherwise stated, 0·1in. per candle, and the filaments are drawn "life size."

All of these lamps were bought in the winter of 1886-87 of supply companies in Boston, out of stock, and presumably could not in any way be picked lamps.

The Edison lamps had the copper-plated shanks, and are now (1889) known as the "old lamp." The Weston 110-

DATA AND PLOTS OF VARIOUS INCANDESCENT LAMPS.—PLATE II.

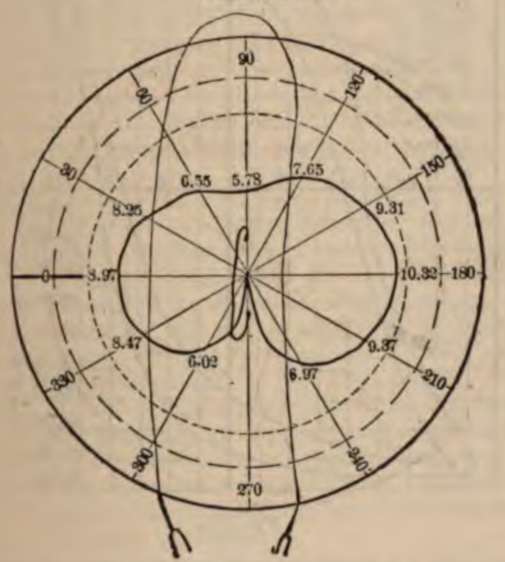
HORIZONTAL



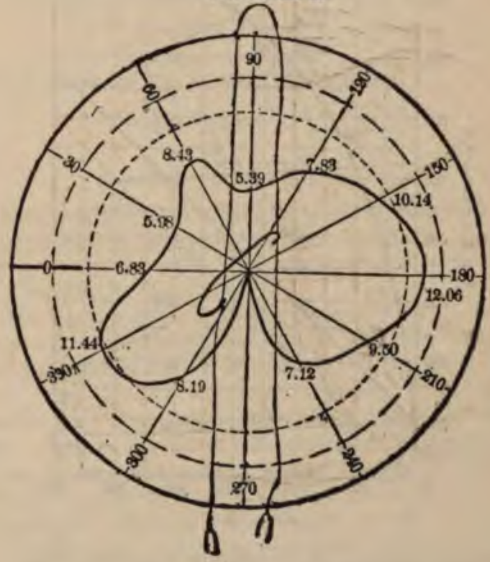
Lamp.—Weston, 110 volt. 16 c.p.
Mean standard reading = 8.97.
Mean spherical c.p. = 10.96.
Spherical reduction factor = 1.222.
Mean horizontal c.p. = 13.37.
Horizontal reduction factor = 1.491.
Mean spherical c.p. ÷ mean horizontal c.p. = 0.820.
Volts. = 110.1.
Amperes = 0.530.
Watts = 58.36.
Watts per mean spherical c p. = 5.32.
Watts per mean horizontal c.p. = 4.36.
Rated c.p. = full circle.
Mean spherical c.p. = dotted circle.
Mean horizontal c.p. = dashed circle.
Section of filament = ▬
Scale, 10 c p. per inch. W.L.P.

Full circle reduced from 3.2″ to 2.5″ in engraving.

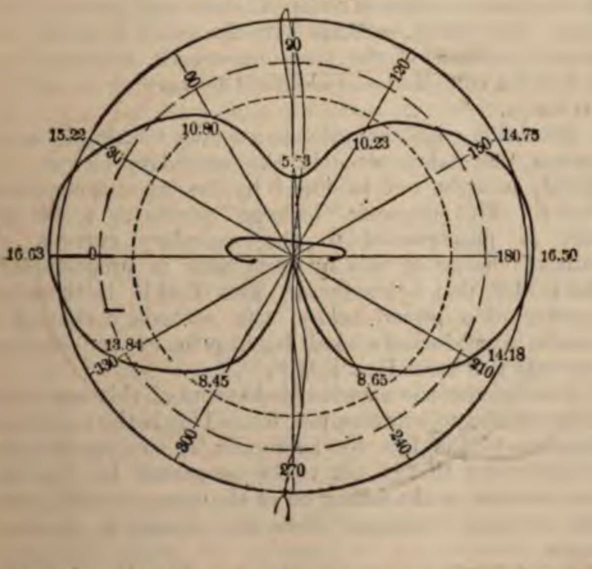
VERTICAL 0°



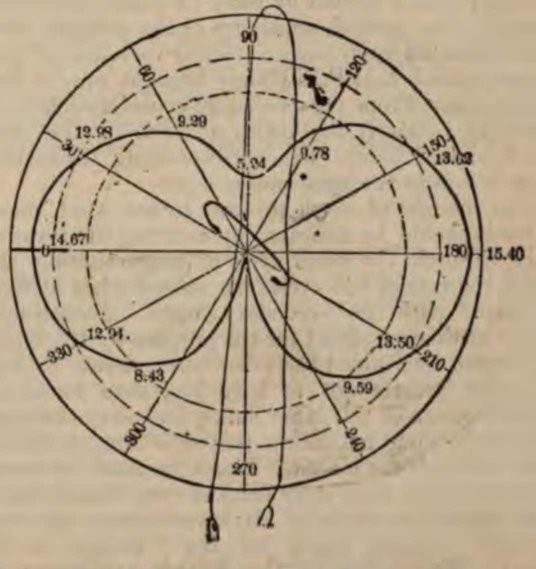
VERTICAL 45°



VERTICAL 90°



VERTICAL 135°



volt lamp is not now in the market, and I believe was on sale for only a short time after these were bought, an improved lamp taking its place. I do not know whether the 70-volt Weston lamp of the kind tested is in the market or not. The Thomson-Houston and Swan lamps appear similar to those now in the market, and are, as far as I know, the same.

(*To be continued.*)

TRANSFORMERS.[*]

BY HARRIS J. RYAN.

(Concluded from page 58.)

In Fig. 10 these values have been plotted to scale there indicated, and the respective curves that they determine have been drawn so that one can plainly see the exact performance of the transformer under all loads.

It is interesting to note that this transformer might be loaded to twice its rated capacity and the heating of the coils would still be less than that of iron, although the heat produced by the iron grows less as the load comes on. Likewise, that its efficiency would not yet have reached its maximum, and that it would have a value of 92 per cent. In Fig. 10 the outer curve represents the relations between the magnetising current in the primary and the degree of magnetisation for all points of a complete cycle. The values locating the curve expressing this relation were readily deduced from the observations made when the transformer was working on open circuit. In Fig. 5 the dotted curve represents the curve of primary current that would be found should Foucault currents be known to be absent, and the relation of ampere-turns and magnetisation be the same going up as coming down. Then if Foucault currents were present the dotted curve would have a component at a quarter of a period in advance. This would produce a negative lag in the dotted curve. From the position of the actual primary current it is plainly seen that but a very small component of the above nature is possible, and that the energy that is wasted by eddy currents must therefore be small. The radical departure of the primary exciting current from the approximate sinuous variation of the primary impressed E.M.F. is plainly brought out to be due to hysteresis. From the preceding consideration it is also evident that almost the entire advance of the exciting current and therefore the corresponding dissipation of energy is due to the same cause.

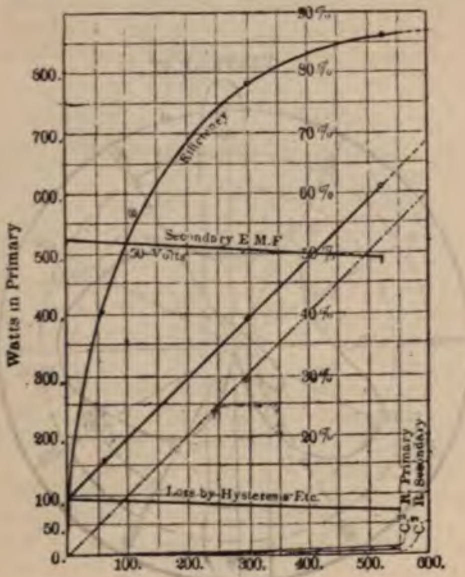


FIG. 10.

It was thought of much interest to see what amout of hysteresis should be indicated by carrying the transformer slowly through the same cycle of magnetisation that it went at the rate of 138 cycles per second when at work on the circuit with its secondary open. Accordingly by Ewing's method, modified for the purpose by Dr. Sumpner, Mr. Merritt determined the inner curve shown in Fig. 10. We regret greatly not to have had time for a careful redetermination of this inner curve, and carry the magnetisation to the same maximum that was done in the transformer when on the circuit. The agreement between the cards would have been more marked even than in Fig. 10.

The assumption made by Mr. Swinburne in his remarkable and valuable paper on the "Design of Transformers" (*Proceedings* of the British Association, 1889) would therefore be fully substantiated. Mr. Mordey's experiments, in which hysteresis and Foucault current losses producing a common loss were determined, were performed by cycles of magnetisation produced by rotation in which the degree of magnetisation did not vary in amount but direction, and cannot be said to throw light on the correctness of Mr. Swinburne's assumption. Some, commenting on this paper, have used Mr. Mordey's results as evidence that these assumptions are wrong.

By a knowledge, then, of the magnetic properties of the iron with which a given transformer is to be built, and the methods made use of by Mr. Swinburne, its efficiency is something that can be correctly predetermined.

The importance of making a transformer produce the same E.M.F. at the terminals of the secondary under all loads, asserts itself when it is used for incandescent lighting. In the transformer under consideration, from the ratios of the primary and secondary turns, the E.M.F. that they produced, and the variations of magnetisation that had to take place through the primary in order that the same should produce an E.M.F. equal and opposite to that of the primary impressed E.M.F., the magnetisation produced through the secondary and the magnetisation set up about the primary in its own air space, are determined. In the present transformer this "leakage" of magnetism amounted to about 1·2 per cent. When the transformer works on full load 4·5 times as much current passes through the primary and the "leakage" of the primary in its own space is 4·5 times as much as on open circuit and becomes 5·4 per cent. This value, together with the small drop due to the actual resistance of the transformer-coils, accounts for the fall of 3·5 volts that was observed by turning on all of the 10 lamps.

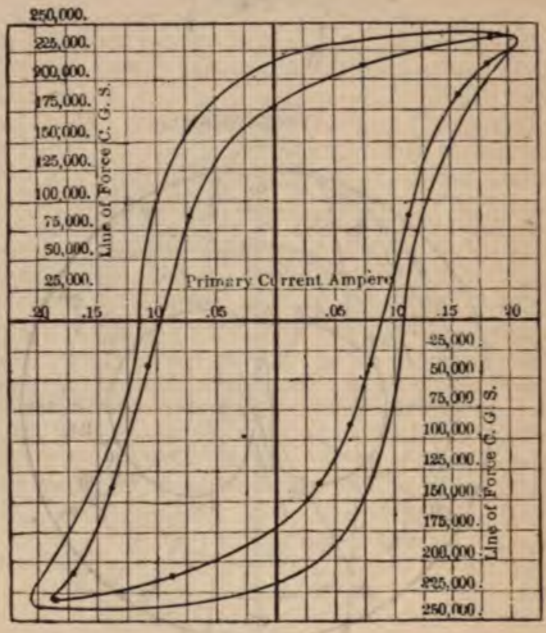


FIG. 11.

Attention might be called to a similar "leakage" in magnetism that takes place in the secondary circuit. It is plainly brought out in Fig. 8 by the lag of the secondary E.M.F. This magnetic "leakage" producing a self-induction is proportional to the secondary current. The rate of change of this quantity then is proportional to the E.M.F. that it produces. This E.M.F. is therefore a quarter of a period behind the secondary current and results in producing a small lag in primary and secondary currents and secondary E.M.F.

Finally, there is a curious behaviour of this transformer that remains to be accounted for. This is the considerable decrease in the loss by hysteresis as the transformer is loaded down, that is not to be accounted for by rise of temperature or the falling off of the magnetisation due to the increased "leakage" about the primary in its own air space.

The following reason suggested itself to the writer why this should take place:

Mechanical shock has been shown to greatly reduce loss by hysteresis when iron is passed through cycles of magnetisation. Since the currents are at all times opposite each other in the two coils of a transformer, strong repulsion occurs when these currents are at a maximum, and no force is exerted when they pass through zero. So it follows that they continually keep thrusting each other apart when at work, and add to the disturbance of the laminated iron that already exists on account of its changing magnetisation. This increasing of the mechanical vibration of the iron may therefore account for the above-mentioned phenomenon.

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[*] Paper read before the American Institute of Electrical Engineers, *New York, December 17, 1889.*

On open circuit the maximum magnetisation of the iron per sq. cm. was 3,850 C.G.S.

Loss by hysteresis per cycle per cubic cm. neglecting Foucault currents ·046 watts at 138 alternations per second.

Coercive force per cm. of the iron 2·76 C.G.S.

In conclusion, the writer would say that the data here given show for themselves so clearly the advisability of providing some practical means for breaking the primary circuit of the transformer when not in use, that the strong advice of Mr. Swinburne in concluding his paper need not be repeated.

LITERATURE.

Electric Light. Its Production and Use. By JOHN W. URQUHART. Third edition. London: Crosby Lockwood and Son.

When a book has reached a third edition it is a plain proof that the author has supplied a want. This book of Mr. Urquhart's contains a good deal of very interesting information, especially in the parts where he gives dimensions and working cost, though we hardly think an author is called upon to give catalogue prices. It would have been better also to have consistently used the same notation throughout the book, but we find both I and C used for current. The history of secondary batteries has yet to be written. When it is written many queer details will be given, and it will be found that M. Faure, for example, really only did what many people had done before. That reminds one of another electrical incident, about which people would like to know more. Was it telephonically or phonographically that Herr J. B. Schalkenbach transmitted sounds to a distance. Electromagnets played a prominent part in the matter, but that is about all we definitely know. Surely there are many people alive who visited the performances in the early sixties. However, this is a digression, and we are quite sure if Mr. Urquhart's book treated of telephony he would endeavour to find out something on the point, for he seems to have read widely about all that concerns electric lighting. For those who desire a general description of the apparatus used in electric lighting this book is adapted.

Traite Elementaire de l'Energie Electrique. Par Prof. E. HOSPITALIER. Tome Premier. Avec 253 figures dans le texte. Paris: G. Mason, 120, Boulevard Saint-Germain.

This is the first of two volumes of a book upon electrical matters. It treats of definitions, principles, general laws, and measurements, while the succeeding volume is to treat of electricity in its industrial applications. The work is of a kind in which French authors excel, gathering together in a compendious form the facts and formulæ generally accepted at the present time by the advanced workers in the subject. Each subject is treated in its own paragraph by a plain statement of the facts relating to it. So far as we can see, the work is that of an editor rather than what is usually termed an original one, and such compilations are of great value, especially when well done, as this seems to be—for the result of all recent investigations are, as it were, tabulated ready for use. We certainly have had enough of historical disquisitions giving us over and over again something from Thales, onwards. Nothing of this kind is to be found in the work under consideration, but the author seems to have had in view from first to last to give information that ought to be useful to the electrical engineer. Much has been put in, perhaps, that others would have left out, but so far as we have examined, nothing seems to have been overlooked that ought to be in—even the recent investigations of Hertz and Lodge finding a due place therein. The electro-graphic, first made popular by Hopkinson and since so largely used by writers like Ewing, Kapp, Thompson, etc., is freely employed. We are glad to see that Prof. Hospitalier accepts the view that a law similar to Ohm's law holds good for the magnetic circuit. On this point, p. 392, paragraph 390, he treats the subject as follows, under the heads—*Magneto-motive Force*, *Magnetic Resistance*, and *Specific Magnetic Resistance.*

For some years it has been proposed to utilise for calculations the similarities, first shown by Faraday, between the electric and the magnetic circuits, and to apply to the latter Ohm's law with all its consequences. Although there are certain powerful theoretic objections to this, the simplifications that this introduces into calculations are so numerous, and the formula has so direct an application, that we believe it will be useful to give the general idea.

In the conception of the magnetic circuit, the flow of force, Φ, corresponds to flow of current, C, the cause of flow is called magneto-motive force, F, which may be written—$4 \pi N C$. When N indicates the number of turns of wire upon a solenoid traversed by a current, C (in C.G.S. units), and the magnetic resistance of the circuit, R, is equivalent to the electric resistance, R, Ohm's formula applied to the magnetic circuit then takes the form:

$$\Phi = \frac{F}{R}.$$

If the magnetic circuit is of known length and sectional area, calling ρ the specific magnetic resistance, a factor the inverse of permeability, μ, we get a formula similar to that for specific electric resistance (par. 168)—

$$R = \rho \frac{l}{s} = \frac{1}{\mu} \cdot \frac{l}{s},$$

which gives for the complete expression

$$\Phi = \frac{4 \pi N C}{\frac{1}{\mu} \cdot \frac{l}{s}} = \frac{4 \pi N C \mu s}{l}.$$

The magnetic permeability, μ, being a simple coefficient, it results from this analogy that magnetic resistance has for dimensions, in the electromagnetic system, the inverse of a length (L^{-1}).

For the specific magnetic resistance of dielectrics, comparisons are made with air which is taken as unity. All *magnetic* bodies have a resistance smaller than that of air, and consequently a greater permeability. *Diamagnetic* bodies, on the contrary, have a greater resistance than air, etc. In this quotation we have taken the liberty of putting C for I, because we do not intend to use I to signify current. We also prefer to continue to use the term "lines of force" as against "flow of force," used by M. Hospitalier, and cannot see that the latter is simpler or that it "implies an idea of continuity more in conformity with the reality" than the former, these reasons being given for the use of "*flux de force.*"

The views held by M. Hospitalier seem generally to be those of the advanced section of workers, hence we can commend this book as likely to save a large amount of trouble in seeking for and wading through original papers scattered over the *Transactions* of learned societies.

1889.

WOODHOUSE AND RAWSON UNITED, LIMITED.—This company, as is well known, has taken over the business of Woodhouse and Rawson, Limited, Woodhouse and Rawson Manufacturing Company, and Woodhouse and Rawson Supply Company, together with other businesses at Manchester and Bradford, and has only been in existence six months, and therefore we shall prefer to make record of its work during the past year as if it had been in existence during the whole year.

As regards its manufacturing business the extension has been steady and thoroughly satisfactory, Mr. Charles Baker, whose business was taken over by this company, being in charge. The old specialities, which are too well known for enumeration, have been further improved, and the total number produced have been largely in advance of previous years, the turn out of one size of switches alone being over 1,500 per week. In addition, several specialities have been worked out and acquired. Chief among these we may note the new insulating substance which is just being put upon the market, and which, for all purposes to which slate has been hitherto used, appears to have a most promising future. We are promised further details with regard to this very shortly. To this we may add Scott's electric flashing lantern for signalling purposes, which strikes out a totally new line, and experiments upon which have been most successful on board one of Her Majesty's ships during the past four months. Scott's log appears to meet a great demand in a very simple manner. A description of this has already appeared in a previous issue. Other specialities are their new oil filter and sight-feed lubricator, and we hear of very important improvements in incandescent lamps. The company still continues to be a large manufacturer of automatic boxes of various kinds, both electrical and mechanical.

In the supply department the extension of business has been remarkable, and recently important arrangements have been made for the supply of large quantities of goods to electrical companies abroad. Roughly speaking, the quantity of business done during the slack season has been well in advance of that done in the busy season the previous year. By the transfer of showrooms and warehouse to 30, Cannon-street, the company has made an enormous improvement, and though it is not yet completely established in its new premises, little remains to be done, and business of all kinds will be greatly facilitated by the extended opportunities afforded to buyers of inspecting all classes of electrical goods.

In common with most electric firms, the contract department of Messrs. Woodhouse and Rawson United, Limited, has been very busy. It has been principally engaged on electric lighting work, but transmission of power for farm and domestic purposes has been carried out. Police alarm systems, bells, telephones, and plating work have also added their quota to a year's industry. A noticeable and satisfactory feature has been the number of repeat orders from former clients. Among the more important may be mentioned (in house lighting) Lord Brassey, Sir F. Carden, Scrase Dickens, Esq., (in factories, etc.) Messrs. J. J. Murphy's brewery, Messrs. Findlater's, etc.

Among the most important contracts carried out are the palace of the Maharajah of Mysore, Lord Ripon's house, etc. This department also does a considerable amount of maintenance work, such as that of Drapers' Hall, Exeter Asylum, and various private places. At the Northern branch of the company's business installations have been carried out at Messrs. Winterbottom's Victoria Mills, Weaste; Falcon Cliff Hotel, Douglas, Isle of Man; Messrs. Crook, Frank, and Co., Hulme; Messrs. Dobson and Barlow, Bolton, and other important works. Contracts for the supply of instruments have been filled with the following: London and North-Western Railway, Caledonian Railway, Manchester, Sheffield, and Lincolnshire Railway, National Telephone Company, as well as the Admiralty and other Government departments. The engineering department have been very busy, especially in the screw-making section, and a large amount of new plant has been laid down to enable the orders in hand to be executed.

By the acquisition of the Bradford business, where installation work is very brisk (the company being specially appointed as contractors to the Corporation), the sphere of the company's operations in this department has been considerably extended in the North of England. Among the installations carried out by this branch may be mentioned those at the Menston Asylum with extensions of the same, Star Music Hall, W. Ackroyd and Co., Sir Titus Salt, Bart., Sims and Co., etc. Electric light has been installed in a large number of buildings in connection with the Corporation electricity supply, and the only limit to extension of work in this direction is the want of power necessary for the increased number of lamps demanded by the public.

In the early part of the year the company identified themselves with the Elmore depositing process, full description of which has appeared in our issues. Careful experiments were made by the company's electrician, which more than fulfilled the expectation held out by the inventor. An English company has been formed which is just now commencing work, and if we may judge from the market price of the shares, which stand at over three times their face value, the undertaking is likely to be one of remarkable success. If it proves to be all that it claims, it cannot fail to be one of the most important commercial undertakings allied with electricity that has yet appeared. It is rumoured that the application of the same process to another important metal is likely to appear very shortly, but of this we have no definite information.

By allying themselves with thoroughly sound and important inventions of this nature the company has given electricity valuable assistance, and we have no doubt that with its new and powerful directorate, coupled with its excellent working staff, its progress in the future will be even more pronounced than in the past. The company has already declared an interim dividend of the rate of 15 per cent. per annum.

CANFORD HALL.

The seat of Lord Wimborne, Canford Hall, near Bournemouth, has received a most extensive installation of electric lighting, no fewer than 1,200 lights are used for this purpose. In the grand hall, or ballroom, there are 300 lights, each light being either of 8, 16, or 32 c.p. Suspended from the roof are two magnificent 50-light chandeliers, the brilliancy of which has a grand effect. There are also in this noble hall eight 5-light brackets and a large number of other lights on corbels in the roof which aid immensely in showing up the gilding and otherwise superb adornment of the hall. In the dining-room there are two 25-light electroliers, eight 5-light brackets, and two 5-light table lamps, hooded with artistic shades of delicate colours. In the drawing-room is a magnificent 42-light electrolier, in the centre; eight 5-light brackets, and about six of the ornamental table lamps. In the library two electroliers of 16 lights each are suspended; there are two 10-light brackets, and in addition to these about 10 table lamps. The illumination of Lady Wimborne's boudoir has a very lovely effect, as the lights and tinted shades harmonise so beautifully with the delicate and rich furniture of the room. In this room, especially, the table lamps are magnificent, being very delicate and beautiful specimens of Dresden china. Lord Wimborne's study is illuminated by a 10-light central electrolier, while disposed about the room are three or four table lamps. The whole of the bedrooms, of which there are no fewer than 45 "best" bedrooms, are all most conveniently lighted by electricity; the new mode of lighting having superseded any and every other form of illumination used in Canford Hall. By the arrangements made a central light can be immediately obtained on opening any door—whether of bedroom or other apartment—as a switch has only to be touched in order to produce the light. These switches are arranged on the same principle throughout the house. Being of uniform height, and always on the right-hand side, whether attached to bedrooms, corridors, or other apartments, they are readily found by the hand. In each of the best bedrooms, in addition to the central light, there are also two candlestick lights, and a reading-lamp by the bedside, which can be switched off from the bed itself. Where there is a canopy over a bed the light is hung with a counterweight above the bed, so that in case of any lady or gentleman reading in bed the light may be easily drawn down, or pushed up, or extinguished as desired.

In the billiard-room there are over the centre of the table six 32-c.p. lamps, four lights in the ceiling, and table lamps in various parts of the room. The standard which supports the central lights over the table is a choice specimen of hammered iron, all wrought by hand. In the servants' rooms the lighting is, of course, not so elaborate. In each of these there is one single light, which, however, is ample. The entrance hall is illuminated with five 16 c.p. lamps. The vestibule has a 12-light electrolier, and in the spacious long gallery there are two 16-light electroliers. As may be judged, the general illumination of the building is of a most elaborate description. It may be added, in order to show the extent and magnitude of the installation, that there are somewhere about 20 miles of electric wire employed in the house.

The motive power for this installation is obtained from two 16 h.p. Davey-Paxman's semi-fixed compound engines, and two 24-unit dynamos. There is a massive switchboard 5ft. square fitted with instruments for measuring and regulating the number of lights in use throughout the house; the number burning is therefore obtainable at any time. In the accumulation-house there are 104 E.P.S. 31 Lcells, this being equal to the storage of 400 lights for eight hours. The whole of this very successful work has been carried out by Mr. J. Adams, of Messrs.

Edmundson's, Limited, Great George-street, Westminster. The installation was commenced on the second or third week in October, and was finished and lighted up on December 13, which may certainly be considered as a fine achievement. The electric light has been used ever since without the slightest hitch.

THE ELECTRO-HARMONIC SOCIETY.

Another of the enjoyable concerts of the Electro-Harmonic Society will be held next Friday, January 31st. It will be a smoking concert, and will be held, as usual, at the St. James's Hall Restaurant (Banqueting Room), Regent-street, W., at eight o'clock. Artistes: Master Steward, Mr. Walter Coward, Mr. Arthur Thompson, Mr. Franklin Clive. There will be a humorous sketch by Mr. A. G. Pritchard; a flute solo by Mr. W. L. Barrett. Mr. Alfred Izard acts as solo pianist and accompanist. The following is the programme:

	PART I.	
Part Song	"In this hour of softened splendour"	Pinsuti
Duet	"Could a man be secure"	Goodwin
	Mr. ARTHUR THOMPSON and Mr. FRANKLIN CLIVE.	
Song	"Dear Heart"	Mattei
	Master STEWARD.	
Flute Solo	Gounod's "Faust"	arranged by De Jong
	Mr. W. L. BARRETT.	
Song	"Rochester Bells"	Marzials
	Mr. FRANKLIN CLIVE.	
Musical Sketch		
	Mr. A. G. PRITCHARD.	
	PART II.	
Glee	"See the Chariot at hand"	Horsley
Pianoforte Solo	"Variations Sérieuses"	Mendelssohn
	Mr. ALFRED IZARD.	
Old Ballad	"I attempt from love's sickness to fly"	Purcell
	Mr. ARTHUR THOMPSON.	
Glee	"The Fisherman's Good Night"	Bishop
Flute Solo	"Scotch Airs"	Richardson
	Mr. W. L. BARRETT.	
Song	"Off to Philadelphia"	Battison Haynes
	Mr. FRANKLIN CLIVE.	
Trio	"Mynheer Van Dunck"	Bishop

COMPANIES' MEETINGS.

EASTERN TELEGRAPH COMPANY, LIMITED.

The thirty-fifth half-yearly general meeting of the Eastern Telegraph Company, Limited, was held on Thursday, the 16th inst., at Winchester House, Old Broad-street, Sir John Pender presiding.

The **Chairman** stated that the gross revenue for the half-year ended Sept. 30 last had been £351,014, or £40,910 in excess of that of the corresponding period of the previous year, about £29,000 of the increase having been derived from messages and £12,000 from additional dividend on their increased holding in the Eastern and South African Telegraph Company. These figures showed that the revenue for the half-year had been exceptionally good, and they hoped that the improvement would continue. He had frequently said at their meetings that their general revenue depended a great deal on the state of trade, and he had also said that the submarine telegraph system was about the best barometer of trade they could have. It was generally admitted that commercial prosperity had prevailed throughout the world, and the past six months' working showed that the Company had shared in the improved state of things. The greater part of the increase in their traffic had been caused by the development of business in South Africa, but, with the exception of India, there had been an improvement in all classes of their traffic. Their total working expenses in the half-year had been £87,730, or £4,398 more, owing chiefly to the increase in their business. Repairs to cables had cost them £49,634, being an increase of £6,559. Their steamers moved about from place to place, effecting repairs in the most silent way possible, and their system was now almost perfect. He had frequently stated that a single line of cable was not to be relied on, and unless they had a duplicate line they could not give that confidence to merchants which the latter required. They did not profess to go in for extreme dividends, but they had endeavoured to put by such an amount as would secure not only their present position but strengthen their position in the future. They carried forward to the next account £61,000, and if they should be as successful in the current as they had been in the past half-year they would have something satisfactory to say at their next meeting respecting the bonus. Africa was now being opened up, and the Company had put themselves in such a position there that at every point of the seaboard communication had been established with the old country. Last year they finished the complete circuit of the whole of Africa. That was the greatest submarine telegraph operation ever carried out, involving as it did about 17,000 miles of cable. They had thus attained a very important position. Among those who had assisted them he was bound to say that England had done a great deal, and as long as the English tongue and the enterprise which followed it continued they would have a wide field for development in Africa. Portugal, which had been generous and liberal to them, had held a position in that country a very long time, and she would have important claims now in regard to Africa if she had shown the same enterprise as the English. France and Spain had also helped them to some extent; but, curiously enough, the only country which had not assisted them in any way was Germany. Germany was now endeavouring to get a hold in Africa, but she had found that she could not do so without doing something for submarine telegraphy. Enquiries were now being made on the part of Germany in connection with this matter, and at their next meeting he hoped he might be able to state that Germany was taking her part in assisting the submarine cable system. The policy of the Company had been to follow the trade and the flag of England. There were two chartered British companies now working in Africa, and he had no doubt that their operations would result in the rapid development of the country. The Company had therefore, without hesitation, laid a cable—he believed it was completed that day—from Zanzibar to Mombassa. He might say that they were on friendly relations with every Government. The Emperor of Morocco had recently visited Tangier, where the Company had landed their cable, and he had given them a site to build an office on as an evidence of his goodwill. The Sultan of Zanzibar had also given them every facility. They had just renewed agreements with France for the next 20 years, and that gave the Company a very strong hold indeed on the Mediterranean system of telegraphs. As far as possible their desire was that the submarine telegraph system should have an international character, and he found that by degrees the different countries were recognising the advantage of such a system. A letter had been addressed by a shareholder to Sir James Anderson (the managing director) with reference to the next telegraph conference, and in reply he had to state that that conference would be held in Paris. The position of the Company was so strong, and they were so useful to all nations, that they did not believe anything would be done to them at the conference which would cause them serious harm. He believed that any concessions they might have to make would be of such a nature that they would produce an increased traffic, and thus prevent their revenue from suffering. The Company had now a little difference with Egypt, whither he was proceeding in a few days, and he trusted that his visit would result in removing the difficulty. He concluded by moving the adoption of the report.

The **Marquis of Tweeddale,** the vice-chairman, seconded the motion, which was carried.

A shareholder named **Clarkson** then desired to address the meeting, questioning the expediency of duplicating and triplicating the cables, and advocating some other means of effecting the same object, but the shareholders objected to hearing him on the ground that he had risen too late.

The retiring Directors and Auditors were re-elected.

DIRECT UNITED STATES CABLE COMPANY, LIMITED.

The half-yearly general meeting of this Company was held last Friday, at Winchester House, Old Broad-street, under the presidency of Sir John Pender.

The **Chairman**, in moving the adoption of the report, stated that the revenue for the half-year ended the 31st ult., after deducting outpayments, had been £42,356, and the working and other expenses, including income-tax, but excluding the cost of the repairs of the cable, had been £15,509, leaving, as the net profit of the half-year, a balance of £26,847, which was increased by the amount brought forward to £29,566. Two interim dividends, each of 3s. 6d. a share, had been paid, leaving £8,318 to be carried forward. The revenue for the six months at the shilling tariff showed an increase of £8,168 over that of the corresponding period of the previous year, when, however, the tariff was at 6d. for two months, and at 1s. for four months. He might mention that the full tariff of 1s. showed a reduction on the "pool" of about 20 per cent. in the traffic as compared with the traffic at the sixpenny rate. Excluding the cost of repairs, the expenditure of the Company in the past half-year had been the lowest on record for any corresponding period since the formation of the Company. They had made every effort, and successfully, to repair promptly any interruption of the cable, and the importance of such action, particularly during a time of competition, could not be over estimated. He might mention that had the steamer been delayed for another three or four days the repairs which were effected on November 12 would in all probability have been postponed for five or six weeks, owing to the bad weather which afterwards prevailed. His idea was that when a break occurred the sooner a ship was despatched to repair the cable the better, and he believed that had that policy been adopted all round there would have been £20,000 more in the pool to divide. That was a large sum to have lost on a half-year's working. Their reserve fund, after being credited with £4,098, the interest on the investments, and debited with £4,119, the cost of the repairs, now stood at £242,000. No addition had been made to the reserve fund out of the past half-year's revenue, but it should be remembered that in the course of the last two years the cable had been renewed in parts to the extent of about £35,000. He would make no proposal that day respecting the reserve fund, but at their next meeting, at the termination of their financial year, he would submit a proposition which he thought would strengthen the Company and not materially affect the dividend. They were endeavouring to devise some means by which they might maintain their income and at the same time build up the reserve fund, which they desired to see stand at its former amount. Their investments, which stood in the balance-sheet at £239,185, were now worth £264,000, or nearly £25,000 in excess of their cost price. He thought the present position of the Company was by no means unsatisfactory. The dividend paid when only six or eight cables were in the Atlantic was 5 per cent., and at that time a considerable reserve was accumulated, which had proved very useful to them. The dividend now paid was 3½ per cent., but there were 10 cables to divide the revenue, a fact which made a very great difference to them. It was a curious fact that when the tariff was 2s., and there were six to eight cables, the earnings never quite reached £1,000,000, though he believed they got up to £950,000. With the shilling tariff they had got up to very nearly £800,000. He believed it would be possible to get the revenue restored to the higher amount named, to nearly £1,000,000, though he did not see his way at all to changing the shilling tariff.

Mr. William Ford seconded the motion.

A brief discussion followed, and in reply to questions the **Chairman** stated that the revenue of cable companies was seriously affected by the coding systems now adopted by the merchants, who by these means mamaged to express a great deal with simply a couple of words. This was a matter which could not be stopped. The use of submarine telegraphs had now, however, become a necessity, and to that fact they must look for their future progress. The Directors had shown the importance which they attached to the reserve fund by increasing it whenever they could do so, and he hoped at their next meeting to make a proposal which would have the effect of restoring the fund to the amount at which it stood before the bad times came upon them. They were so situated with the other companies in the "pool" that they could not alone publish their traffic returns, and he did not think it would be advisable to do so. Their relations with the Commercial Company were perfectly satisfactory. It could not be said that they were competing with each other, except as to who should do the work best.

The motion was unanimously adopted.

NEW COMPANIES REGISTERED.

Electrical Engineering Corporation, Limited.—Registered by Dowson, Ainslie, and Martineau, 28, Bedford-row, W.C., with a capital of £150,000 in £5 shares. Object: to carry into effect two agreements dated January 9, and made between R. B. Rennie (on behalf of the United Electrical Engineering Company) and John G. Statter (on behalf of the Company), and J. G. Statter (on behalf of J. G. Statter and Co., Limited), and E. Manville (on behalf of this Company), being agreements for the transfer to this Company of the respective businesses of the United Electrical Engineering Company, Limited, and J. G. Statter and Co., Limited. The first subscribers are:

	Shares
C. Sannel, 175, Sutherland-avenue, W.	1
W. L. Madgen, 3, Prince's-mansions	1
W. G. Ainslie, M.P., 21, Ennismore-gardens	1
J. G. Statter, C.E., Alliance Engineering Works, West Drayton	1
H. B. Statter, Old Hall, Snapethorpe, near Wakefield	1
P. E. Scrutton, Alliance Engineering Works, West Drayton	1
E. Manville, 3, Prince's-mansions, S.W.	1

There shall not be less than three nor more than nine Directors. The first are W. Statter, H. B. Statter, J. G. Statter, C. E. Charlesworth, C. Sannel, W. G. Ainslie, E. Manville, and W. L. Madgen, of whom J. G. Statter, E. Manville, and W. L. Magden shall be managing directors. Qualification, £500. Remuneration, £250, and one-tenth of profits after 10 per cent. dividend.

PROVISIONAL PATENTS, 1890.

JANUARY 13.

600. **Improvements in the manufacture of brushes for dynamo-electric machines.** John Clayton Mewburn, 55, Chancery-lane, Middlesex. (Honoré Carrière, France.)

607. **Improvements in or connected with engines, vehicles, or machines driven by electric motors.** Ralph Peacock and Hermann Ludwig Lange, 47, Lincoln's-inn-fields, London.

615. **Improvements relating to electric circuits for lighting and other purposes, and to devices for controlling the flow of the current therein.** Richard Brown Evered and Thomas Rudling, 45, Southampton-buildings, London.

JANUARY 14.

665. **Improvements in or relating to reversible electric motors.** Philip John Ribton-Crampton, 323, High Holborn, Middlesex.

693. **Electric motors.** Stanley Charles Cuthbert Currie, 24, Southampton-buildings, London. (Complete specification.)

694. **Improvements in the manufacture of light emitters or illuminants for electric and other lamps.** James Clegg, 24, Southampton-buildings, London.

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JANUARY 15.

718. **Improvements in electric lamp couplers or holders.** Albert Edward Nichols, 2, Great George-street, Westminster.

761. **Process of generating electricity by gas batteries.** Olof Dahl, 104, Tachbrook-street, London. (Date applied for under Patents Act 1883, Section 103, 17th June, 1889, being date of application in the United States.) (Complete specification.)

771. **Improvements in and connected with telephone systems.** Wilhelm Oesterreich and Werner Genest, 77, Chancery-lane, London.

JANUARY 16.

836. **Improved means for preventing disturbing action in long telephonic circuits.** Eugene Dwosdeff and Heinrich Bunge, 28, Southampton-buildings, London.

847. **Improvements in and relating to electrical communicators for use on travelling vehicles** Charles Graham and Frances Allen, 3, Poets'-corner, Westminster.

JANUARY 17.

872. **A dynamo machine for alternating currents.** John Perry, The Finsbury Technical College, Leonard-street, London.

873. **Improvements in electric supply meters.** John Perry, The Finsbury Technical College, Leonard-street, London.

878. **Improvements in and connected with dynamo machines for producing electric energy, ventilation of culverts for distributing it, accumulators for storing it, and motors for utilising it.** James Swinburne, 49, Queen's-road, Wimbledon.

882. **Improvements in linesman's testing galvanometers or detectors.** George William Lummis Patterson, 35, Malcolm-street, Heaton, Newcastle-on-Tyne.

911. **Method of and apparatus for winding ribbons or tapes of insulating material around electrical conductors.** Sydney Pitt, 24, Southampton-buildings, London. (James Bassnett Atherton, United States.)

JANUARY 18.

941. **Improvements relating to electric tramways and tram-cars.** Alexander Login Lineff and Edward Hodson Bayley, 6, Bream's-buildings, Chancery-lane. (Complete specification.)

950. **Improvements in dynamo machines.** Walter Thompson, 41, Eastcheap, London. (Complete specification.)

962. **Improvements connected with cars worked by electric accumulators.** James Swinburne, 49, Queen's-road, Wimbledon.

SPECIFICATIONS PUBLISHED

1888.

19069. **Storing energy in small mechanical accumulators.** Lorrain. 8d.

1889.

3272. **Electric motors.** Thompson (Westinghouse Electric Company). 8d.

3330. **Electric lighting.** Hartness. 6d.

3420. **Dynamo-machines.** Sayers. 6d.

3674. **Distributing, &c., electric currents.** Abel (Siemens and Halske.) 8d.

5152. **Electrical lamp, &c., holders.** Atkins. 8d.

17610. **Electric signalling.** Lake (Morgan). 2s. 4d.

18743. **Electric conductors.** Pitt (Dey). 6d.

18817. **Operating telephone call bells, &c.** Birkbeck (Schneider and Zeidler). 6d.

18953. **Secondary batteries.** Macaulay-Cruikshank (Johnson and Smith). 6d.

18966. **Galvanic batteries.** Enholm. 6d.

18969. **Secondary batteries.** Smith. 6d.

18997. **Connecting an accumulator battery in alternating current circuits.** Boult (Foeppl). 6d.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The receipts for the week ended January 17 amounted to £4,759.

West India and Panama Telegraph Company.—The traffic receipts of this Company for the half-month ended January 15 were £2,930, as compared with £2,454.

Western and Brazilian Telegraph Company.—The receipts of this Company for the past week, after deducting the fifth payable to the London Platino-Brazilian Company, were £3,432.

Cuba Telegraph Company.—After adding £1,000 to the reserve fund, the Board of the Cuba Submarine Telegraph Company, Limited, recommend a distribution at the rate of 9 per cent. per annum, carrying over £404.

Eastern South African Telegraph Company.—The Directors of this Company announce the payment by interest warrant, on February 1 next, of interest for the half-year ending January 31 on their four per cent. mortgage debentures.

Anglo-American Telegraph Company, Limited.—This Company recommend a balance dividend of 15s. per cent. on the ordinary consolidated stock for the year ending December 31; a balance dividend of £1. 10s. per cent. on the preferred stock for the year ending December 31, 1889, both payable on February 1, less income-tax, to the stockholders registered on the books on the 13th inst. After paying the foregoing dividends, there will be an estimated balance of £2,247 to be carried forward. The above dividends, together with those already paid, will amount to £2. 15s. per cent. on the ordinary and £5. 10s. on the preferred stocks for the year 1889.

NOTES.

Barnet.—An attempt will be made to obtain at least 400 lights in Barnet and the district, and introduce the new system.

Award.—The committee of the late electrical exhibition at Birmingham have awarded Messrs. Ruston, Proctor, and Co., a special first-class gold medal for their compound fixed engine.

The French Post Office.—M. Coulon is leaving the post of Director of Post Telegraphs and Telephones in Paris. M. Selves, prefect of the Gironde, is expected to take his place.

Dividends.—An interim dividend is announced of profits since the formation of Woodhouse and Rawson United, Limited, of 8 per cent. on the preference and 15 per cent. on the ordinary shares.

Gas in America.—It is interesting to note that, notwithstanding the enormous development of electric lighting in America, the gas supply yet increased in 1889 by 10·6 per cent over that of the year before.

Cantor Lectures.—The third of the lectures by Prof. Silvanus Thompson on "The Electromagnet" will be given before the Society of Arts next Monday, at 8 p.m. Subject, "Special Designs of Magnets."

Bury.—Sanction to the application of the Lancashire and Cheshire House-to-House Company for a provisional order was refused by the Bury Town Council, inasmuch as the Corporation are making similar application.

Eastbourne.—The Eastbourne Town Council, at a long meeting in committee, considered the application of the Eastbourne Electric Light Company for a provisional order, and, after a full discussion, agreed to give an unconditional assent.

Central London Railway.—At the Holborn District Board a memorial from inhabitants of Oxford-street was read, asking the Board to oppose the scheme, but on the motion of Mr. Trenner, it was resolved not to oppose the scheme.

Ipswich.—The sub-committee have had an interview with the engineer of the Brush Electric Company, and a compulsory area of supply was decided upon. The question of an appointment of an electrical inspector was mentioned.

Cheltenham. — The Electric Lighting Committee reported that notice had been given to the Board of Trade that application having been made by the Corporation for an order, they objected to the granting of an order to any other applicant.

Italy.—The public electric lighting of the town of Cuneo was inaugurated on the 15th inst., and on the day following the public installation at Parma was also opened. We hear that a number of other towns in Italy are being similarly installed.

Electric Lighting in Berlin.—The total number of electrical lamps in use in Berlin in March last was 3,774 arc lamps and 62,876 incandescent lamps. This number corresponds to about 85,520 gas lights, or 10 per cent. of the town gas production.

Defective Cables at Chelmsford.—After the overhead lines at Chelmsford were run, it was found that the cables were of greatly inferior quality to those specified, and Messrs. Crompton have determined to take down and return the defective cables.

Gas-Electrics.—The gas company of Somerville, New Jersey, have tendered for and received a contract to light 70 lamps every night and all night at 6s. 3d. per lamp per month. The Somerville Electric Company, who also tendered, were completely cut out.

Electric Snow Sweeper.—The Thomson-Houston Company are constructing seven new snow ploughs and sweepers for the West End Company, of Boston. They are designed to be used on the electric lines, and are similar to the old ones drawn by horses.

Switzerland.—The firm of MM. C. Blanc et Cie., electrical engineers, of Marly-le-Grand, Fribourg, has been made into a limited company with a capital of half a million francs under the name of the Société Suisse pour la Construction d'Accumulateurs Electrique.

A Central Station.—One of the blocks of offices in Chicago which boasts of being the tallest building in the world, has just had an electric installation ordered for it which will make quite a small central station of itself. The installation is required for 3,800 lights.

Corporation Lighting at Brighton.—The Brighton Corporation have decided to establish electric lighting works at an estimated expense of £30,000 under the provisional order of 1883. The system is to be that of the continuous current at low pressure, combined with storage batteries.

Electrical Appointments.—While various corporations have now in mind the question of appointing their own electrical engineers it is interesting to note that the city of Cincinnati, Ohio, has just opened an appointment for city electrical engineer, at a salary of 2,500dols., say £500 per annum.

Rochester.—The Chatham and Rochester Electric Company have now two-thirds of their lights running, and it is expected by the end of the year the whole of the available current will be taken. A change in the management of the works has taken place, and Mr. A. Maund has been appointed manager.

Overhead Wires at Exeter.—A resolution was brought before the Exeter Town Council to refuse consent to further extension of the electric wires. These it was explained were temporary, having all to go underground within three years, and in order not to cripple the company the resolution was abandoned.

Leamington.—In an interview, Mr. Arthur Chamberlain stated he was sorry for any lighting company who attempted to start in Leamington. While in an ordinary town the average income per lamp a year was from 25s. to 30s., in Leamington it was only 12s. 2d.; and yet the inhabitants there were always complaining.

Hendon.—The committee recommend that the Local Board do not give consent, and that the solicitor be instructed to submit the objections to the Board of Trade. It was thought that if granted the company should be compelled to take steps within a stated time and within a shorter period deposit a sum of money or commence work.

Should be Imitated.—The manager of the motor department of the Edison Illuminating Company at Boston, U.S.A., has issued a leaflet, with information about the use of electric motors, with the current required for various horse-powers, prices for the current, and a list of customers using the electric motor power in various trades.

Direct Cables.—The Western Union Telegraph Company announce that two submarine cables have now been completed between Nova Scotia and New York, establishing direct cable communication from England into their office at 16, Broad street, New York City.

Rail Scraper.—A scraper for tram rails, suitable for use on horse or electric cars, is introduced by Mr. H. H. Littell, of Louisville, Kentucky. A pair of steel scrapers, formed to the shape of the rail, can be depressed by the driver or motor-man by simply placing his foot on a lever, and any dirt, ice, or snow is cleared out of the track.

Electricity for London Tramways.—The London Tramways Company have introduced a Bill, which was considered by Mr. Campion, examiner for private bills, last week, for the purpose of applying electricity as a motive power for their various systems of tramways, by means of wire ropes, chains, or other electrical apparatus placed underground.

Richmond.—Notices of objection to the two companies—the Brush and the House-to-House—applying for power to light Richmond were discussed at the last meeting of the Richmond Vestry, and a resolution that these notices be sealed and forwarded to the Board of Trade was carried. Mr. Hilditch stated it was certainly the intention of the committee to proceed.

Ealing.—In considering the application of the House-to-House Company, the chairman of the Ealing Local Board said he thought the lighting should be in the hands of the local authorities, and gave notice that, as it was too late to apply for an order, he would move a resolution empowering the Board of Trade to apply for a licence at a special meeting to be held on February 20.

Beckenham.—A report was presented by the committee to the Local Board suggesting that the application of the Electric Construction and Maintenance Company be approved if a clause giving option of purchase in 10 years were inserted. On it being remarked that probably the Board of Trade would not agree, the clerk was instructed to confer with the parliamentary agents.

Balloon Society.—At the weekly meeting of the Balloon Society on Friday last, Sir John Bennett lectured on "Electric Power, the Light of the Future." Mr. Geo. Offor was chairman, and also spoke on the advantages of electric lighting. A motion advocating that the business of electric lighting should be in the hands of companies, rather than public authorities, was adopted.

The Telegraph Imperfect.—At the discussion before the American Institute of Electrical Engineers on Mr. P. B. Delany's paper on "Telegraph Line Adjustment," the chairman said, "There is probably hardly any electrical invention to-day which is so imperfect as the telegraph, and we have reason to be thankful to such men as Mr. Delany for devoting their attention and talent to perfecting it."

Electrical Gifts.—We have received a very neat and useful paperknife which Messrs. Woodhouse and Rawson are distributing at cost of postage. It is made of white celluloid in imitation of ivory and lettered in gold, marked on one side in inches and centimetres, and on the other as a daily calender. They also send a calender for the office wall, with numerous illustrations of the most useful of their apparatus.

Messrs. Gatti's Station.—A letter was read at the Strand District Board from Messrs. Fladgates, with draft provisional order of Messrs. A. and S. Gatti, to construct and maintain electric wires, and to supply electricity within a portion of the district. There was a strong feeling expressed against sanctioning the application, but the matter was referred to the Lighting Committee to consider and report.

Explosion at Sardinia-street.—On Wednesday morning there was an explosion on the premises of the Metropolitan Electric Supply Company, Sardinia-street, Lincoln's-inn. A man named Morris, who was putting some coal into the stoke-hole at the time, was knocked down and badly injured, and was taken to the hospital. The accident was due to the cover of the blow-off not being properly secured.

Arc Lamp Intensity.—In future all contracts for public lighting in Philadelphia will be based upon the current furnished and not upon the c.p. of the lamps. This action was due to the measurement of the power of the lamp showing that of the nominal 2,000 c.p., the Thomson-Houston gave only 1,160, and the Brush 936 c.p. The United Company's lamps 1,000 c.p. nominal yielded 479 candles when measured.

Electric Cooking.—Mr. Fred Royce, of Washington, is reported at work upon some important improvements in the direction of electric cooking. There is very little doubt that a little attention in this direction might repay inventors. Electricity when laid on in the houses has only to be tapped to be immediately useful. The great advantage of the gas fire over coal or coke is its almost immediate applicability, and in this respect also, besides that of smell, electricity would have distinct advantages.

Electricity in the Dairy.—An interesting application of electricity to the dairy industry has been recently made in Italy. The Count of Assata, whose buildings are fitted up with the electric light, has connected his dairy plant with an electric motor of 12 h.p. This machine drives a Danish separator and a Danish churn of the capacity of 400 litres of cream, churning being conducted at the rate of 120 to 160 revolutions per minute, the butter being brought in from 30 to 35 minutes, in fine grains, which, it is now recognised, enable the maker to produce the finest article. A pump is also worked in the dairy.

Reading.—Major Cardew has made a report upon the installation of Messrs. Laing, Wharton, and Down at Reading, and recommended sundry alterations for the safety of the public. Insulation tests are taken daily before and after each run, and this he recommends should be strictly carried out. The company have instructed their engineer to comply with the requirements. With respect to the applications of this company and the Brush and the House-to-House Companies, the special committee recommended that consent should not be given, as the Corporation intend themselves to apply for a provisional order next session.

Public Lighting.—It is almost exactly eighty-three years ago—the 28th of January, 1807—since Pall Mall was first lighted with gas, the first public place so lighted. Wonderful as has been the spread of gas lighting since that time, it is fair to anticipate a far quicker introduction of electric lighting to the universal position which gas now holds than fourscore years. At the same time, as more oil lamps and tallow candles are now used even than then, so a yet more extended use may be expected to be found to the now discredited gas. For public lighting, however, it may be expected to be as much doomed as were oil lamps at the advent of gas in 1807 in Pall Mall.

Newcastle.—For the first time the Newcastle and District Electric Lighting Company have connected their light to Quayside, a hitherto untouched part of Newcastle. On Tuesday the electric light current was switched on to Messrs. Wm. Milburn and Co.'s offices in Queen-street, everything going off without a hitch, the light remaining steady and brilliant. The company has received numerous applications from merchants on the Quayside to supply them with electricity from their mains, and it is anticipated that before long a large number of offices will be lighted with the new illuminant. The company is still proceeding actively with the work of laying cables, and fresh consumers are daily securing connections with the mains.

Popp's System in Germany.—As we mentioned a short while ago, the extension in Paris of Victor Popp's system of electricity and power distribution by compressed air was understood to have been aided largely by German financiers. The introduction of the system to Germany itself was therefore looked for, and the formation of a limited company is now announced from Berlin. The company is to have a capital of 30,000,000 marks for the purpose of establishing the system of distribution in German towns. The shares are offered to the public by a syndicate of leading firms, such as the Disconto Gesellschaft (Berlin), Dresdener Bank (Dresden), Norddeutsche Bank (Hamburg), Oppenheim (Cologne), and Bethman (Frankfort).

Cardiff.—Major-General Webber waited on the Cardiff Committee, as a representative of the Brush Electric Light Company, to request the committee to give their official approval to the application which they were about to make for a provisional order. The Brush Company, he pointed out, had had some lights in Cardiff for some time. Since the Act of 1888 was passed, it was quite evident that a mere provisional order did not in any sense involve a monopoly. Other companies could do the same, and could actually supply lights to exactly the same district—so could the Corporation itself if it thought proper, even after the provisional order was granted to his company. The mayor, after courteously hearing the major-general, said they had given the matter full consideration, and they could not change the attitude they had assumed.

North Metropolitan Tramcars.—The following highly gratifying and encouraging remarks are from the half-yearly report of the North Metropolitan Tramway Company, to be submitted to their shareholders on the 5th day of February next: "As mentioned in a previous report, an arrangement was entered into with the Electric Traction Company for working the company's cars on the Barking-road section, and the directors are glad to state that the results during the half-year have been satisfactory. The electric cars have run 34,366 miles, and have carried 469,095 passengers. The cost to this company for electric traction has been 4½d. per mile run (including the wages of drivers), which is less than the average cost per mile run for horse traction over the entire system. The Barking-road section is a short single line with loops, requiring only a low mileage, with a small number of cars, which does not offer such facilities for economic working as a longer line would, with a higher mileage and more cars worked by a larger installation; but the result of the working of electric cars on the Barking-road justifies the directors in hoping that Parliament will sanction the introduction of electric power over the company's system, and enable them to extend its application to other lines."

Telephones from London to Manchester.—At the invitation of the National Telephone Company, several gentlemen interested in electrical industries attended at the Manchester Exchange, on Wednesday last week, to experiment with the new telephone line which has been constructed from Manchester to Edgware, nine miles from London, and which will shortly be extended to the centre of the capital. The Prince's Theatre was in telephonic communication with Edgware, and the pantomime music was distinctly heard at the latter place. Congratulatory messages were exchanged, and it was remarked that the voices were as audible as, or more audible than, when heard through the trunk wires connecting Manchester with towns in Lancashire, owing to the inductive action being destroyed. It may be some time before the full measure of this development is extended to the subscribers, who, at present, use a single wire; but where the business is urgent the subscribers may communicate from one central exchange to another. Communication between Manchester and Kidderminster was also tried, with good effect. As showing the development of the Manchester business, it may be mentioned that about 2,000 messages a day are now received by the trunk lines alone, which in Lancashire and Cheshire reach 12,000 miles; and the average number of calls of all kinds per day is over 32,000.

More City Lighting.—A meeting of the City Commission of Sewers was held on Tuesday at the Guildhall, Mr. George Manners presiding. This being the last sitting during the continuance of the present Commission, the members, at the instance of Mr. Deputy Bedford, accorded a vote of thanks to Mr. Manners, the chairman, for his services in that capacity. A petition was presented from owners and occupiers of property from Holborn to London Bridge against the Central London Railway scheme. The consideration of the petition was adjourned. The Finance and Improvement Committee brought up a report from the engineer on the several Bills before Parliament affecting the City, and also in relation to the draft provisional orders for electric lighting. They recommended that the measure should be opposed with a view to obtain a *locus standi* before Parliament, and that they should be authorised to watch the progress of the schemes. This was carried. The Streets Committee brought up a report recommending that, inasmuch as the Laing, Wharton, and Down Construction Syndicate were prepared to light a section of the City on the same terms as agreed with the Brush Electrical Engineering Company, a contract be entered into with that syndicate for lighting the eastern division of the City. Mr. Day moved the adoption of the report, which was carried, Mr. W. H. Pannell congratulating the Commission that it had now been arranged to provide two-thirds of the City with the electric light.

Electric Tramcar Extension.—The successful working of the Electric Traction Company's accumulator cars on the Barking-road has aroused much interest in the tramway world throughout this country and abroad. Besides the Liverpool United Tramways, who have already arranged for an experimental demonstration on their line, we hear of enquiries from Newcastle, Hull, Southport, Leicester, and South Staffordshire. The new Lancaster District Tramway, connecting Lancaster with the fashionable watering place of Morecambe, are most anxious to adopt this system on their line, and are prepared to enter into a contract with any enterprising electrical firm not afraid to tackle their heavy gradients. Our colonies, keeping pace with the old country, are on the alert to adopt the new traction power, and have sought the highest expert opinions on the merits of the available systems. The Calcutta Tramways, having a dead level track of about 20 miles, in this respect very favourable to electric power, would be only too glad to get rid of their horses and substitute any reliable and economical mechanical traction. But, considering their present working expenses are only 3½d. per car mile, it is somewhat problematical, at least, with our present knowledge, whether electric trams could be profitably worked at such a low figure. However, labour is extremely cheap, and native coal is obtainable at 12s. per ton, so that it is quite within the range of possibilities that even this price might not be prohibitive, and the advantages over horses would be enormous.

Leeds to Supply its Own Light.—A special meeting of the Leeds County Council was held on Tuesday to consider the undertaking of the electric light by the Corporation. A resolution was moved refusing consent to the National Electric Light Company, Limited, the Yorkshire House-to-House Electricity Company, Limited, and the Electric Installation and Maintenance Company, Limited; and instructing the Electric Light Committee, in two months hence, to report upon the question of electric lighting, with full information upon all improvements which have been made in supplying the light up to that time. Alderman Spark, in moving the resolution, said the Corporation could provide electric light at 2½d. per unit, which meant 20 lamps of 10 c.p. per hour. He appealed to the Council to maintain the position they took up in October last, and not to allow a company to come into the town and supply the electric light, for which the inhabitants, before long, would have to pay an enormous price. He was not talking hearsay. They could supply light at the rate of ½d. per lamp per hour. In concluding, Mr. Spark pointed out the inconvenience which would arise from the indiscriminate tearing up of the streets by a company, and urged that just as the Corporation held the water works, the gas works, and the highways, they should have the management of the electric light. An amendment was moved to consent to the companies coming in, but the resolution was carried by 25 votes to 18. The Mayor then moved that the Council instruct the Parliamentary Committee to take such steps to oppose the provisional orders applied for as might be deemed necessary. This was adopted.

Incandescent Lamps on Buoys.—A recent report made by Captain Millis, of the United States Lighthouse Board, in relation to the electric-lighted buoys at the Gedney's Channel entrance to the New York Harbour, states that a year's service has shown that the system is a practical success. During the last nine months over 220 ocean vessels passed through the channel between sunset and sunrise. The buoys withstood the heavy storms of last September without drifting from their positions, and not more than two lamps out of six were extinguished at any one time. On one occasion, a buoy was run down by a vessel and entirely submerged without injury. Some trouble has been experienced from moisture getting through the lamp-sockets and destroying the connections, but a new form of lamp has been devised which promises to be free from this objection. It has been found that the life of lamps made in red glass globes was much shorter than that of the uncoloured ones, an effect which was attributed to the interception of a greater portion of the heat radiated from the carbon filament, and lamps with bulbs of clear glass are now used on all the buoys, lanterns lined with red glass being used to produce the red lights. Captain Millis notes the fact that a building on shore, very near the buoys, was twice struck by lightning, while the buoys and the connecting cables were uninjured. He thinks it is probable that the use of an earth return ensures greater safety from damage by lightning than it would obtain if the circuits were entirely insulated. Altogether, the report of this experiment seems highly satisfactory, and it might be well if electrical engineers were to press upon the attention of the competent authorities the desirability of establishing electrically-lighted buoys on our own coasts.

London County Council.—At the meeting of the London County Council on Tuesday Mr. T. B. Westacott, chairman of the Highways Committee, brought up a report with respect to the provisional orders, 23 in number, for which application had been made to the Board of Trade, and the three Bills to be introduced into Parliament next session, relating to electric lighting. The recommendations which the committee submitted were as follows: (*a*) That all the provisional orders and Bills be amended so as to make them accord with the legislation of 1889 in respect of electric lighting. (*b*) That provisional orders and Bills comprising areas for which parliamentary powers have already been conferred upon more than one company, be opposed. (*c*) That in respect of provisional orders and Bills relating to the City of London, the Council do seek for the same powers as were conferred upon it by the orders and Act of last year, none of which affected the City. (*d*) That provisional orders and Bills which comprise areas outside as well as within the county of London be opposed, with a view to prevent the area of supply extending over more than one county. (*e*) That in those cases in which the companies desire actually to cross any bridge belonging to the Council, the precedent for which the Council successfully contended last year should be followed, and clauses obtained defining the exact extent of interference which may be permitted in each case. (*f*) That amendments should be inserted: (1) Limiting, to a period not exceeding twelve months from the receipt of requisition from the Council, the time within which the companies are to provide testing stations near distributing mains, subject to a penalty of £10, with a continuing penalty; (2) fixing three weeks as the length of notice of application to the Board of Trade for extension of time for the carrying out of any of the undertakers' duties; (3) providing for three days' notice being given to the Council of commencement of works, sanctioned by the Council, in the streets. (*g*) That, having regard to the fact that the London Electric Supply Corporation has not yet had time to develop the extensive area of supply allotted to it last year, the granting of further powers over the very large new area referred to in the company's provisional order be objected to. (*h*) That, in addition to the above general recommendations, the following orders and bills which relate to the Strand district and the parishes of St. Martin-in-the-Fields and St. Pancras be objected to: St. Martin-in-the-Fields and Strand Electric Supply Order, Strand Electric Lighting Bill, St. Martin-in-the-Fields Electric Lighting Bill, and St. Pancras Electric Light Supply Order. Considerable debate followed, but the recommendations of the committee were approved in their entirety

THE FIRST PRINCIPLES OF ELECTRICAL ENGINEERING.

We have before us advance proofs of a small elementary book bearing the above title which purports to treat electrical subjects more from the engineering point of view than from any other. Whatever be the merits or the demerits of the work, an effort has been made to treat the subject from a new standpoint. The author states that electricity is constant in quantity, and lays considerable importance upon the consideration of the path through which it acts. The first part of the book deals with circuits—viz., the conductive circuit, the inductive circuit, and the magnetic circuit. Probably this division is in deference to other opinion, for the internal evidence seems to indicate the author would consider one circuit only—the conductive—as essential. Somewhat cavalierly, too, the popular notion of the "generation of electricity" is restricted to all the apparatus "generally said to produce electricity is really used to increase the activity of electricity," in fact, to produce "electrical pressure." The term "electrical pressure" is used throughout instead of electromotive force. It is held that "Ohm's law," or a similar law, holds good throughout all the circuits, and the introduction into recent papers and text-books of such terms as "permeability" and "susceptibility" is a step backwards, calculated to retard instead of to assist the student. It is held that as different metals have far different conductivities in the conductive circuit, so among magnetic bodies there are different conductivities for magnetic flow. Commercial iron differs in chemical constitution, and therefore different irons will have different magnetic resistance. It would be far more in accord with notions imbibed by a consideration of the conductive circuit to say certain iron had a magnetic resistance 32 times or 300 times less than the resistance of air. We do not talk of permeability or susceptibility of conductors for current. We say they have different conductivities or different resistance as the case may be, and such should be the method in the magnetic circuit. If air is the unit, then because a certain iron has 300 times less resistance, 300 times more lines of force will go through an equal section of that iron than through a similar section of air, with the same magnetic pressure. We do not speak of lead being less permeable to current than copper. We simply say its resistance is greater, and under similar conditions of pressure, length, and sectional area the current through it will be less. If practical men prefer that air should not be the unit, better agree upon "pure iron," or if that cannot be obtained easily "pure nickel." Magnetic resistance boxes should be made just as conductive resistance boxes are made.

The second part of the book deals with the apparatus used to generate pressure, a short space being devoted to frictional machines and batteries, and a larger space to the consideration of the dynamo. The concluding part of the book describes a few of the measuring instruments usually met with in installation work.

Our views are in accord with many expressions in this small volume, and we must enter a protest against the assumption made that the idea of a "magnetic circuit" is of very recent origin. The fact is not so; but till the requirements of dynamo construction brought the matter into prominence the subject received little or no attention. One hundred years ago less ten, Mr. Walker, though speaking the ideas of the time when referring to the action of iron filings round a magnet, says, "On the sides of the magnet they slope, or incline, and seem buttresses of inclining arches; so that if filings could be sustained all round a magnet they would probably assume an egg-like figure. Is not this appearance favourable to the idea of an effluvium" (we call it lines of force, lines of induction, lines of polarisation) "flowing all round the magnet from one end to the other, *and having a circulation through it.*" Further the same author says, after describing another experiment, "Can this be for any other reason than because the balls and the magnet make one complete magnetic circuit." The balls mentioned form the armature of a horseshoe magnet. Over and over again, this term "magnetic circuit" is used by this author. Our library is not extensive enough to attempt to trace or attempt to interpret the views of these early writers, but in our opinion in those days the ideas both as regards the conductive and the inductive or magnetic circuits were fairly clear. The work of Ohm on the conductive circuit and the application of the conductive circuit to humanity's requirements led to a greater development of all that pertains to that circuit than took place with regard to magnetism and magnetic circuits. Then again it must not be forgotten that till the time of Sturgeon and Henry the electromagnet was unknown, and when better known was used almost exclusively as an appendage to telegraph instruments. It may almost raise a laugh to read Walker's sentence that "Magnets exert their greatest power at their ends, for the wise purpose of catching conductors, to form the magnetic circuit," but there is a good substratum of truth in it.

Let us hark back to the suggestions now being made in this little book. Taking Kapp's formula for the magnetic circuit, analogous to Ohm's, for the conductive circuit—viz.,

$$Z = \frac{P}{R_a + R_A + R_F},$$

Z = number of lines of force, P = exciting magnetomotive force in ampere-turns, R_a = magnetic resistance of air-space, R_A = magnetic resistance of armature core, and R_F = magnetic resistance of field-magnets. This formula leads to others to get the magnetic resistance. It is suggested that the *total* magnetic resistance of the circuit should be measured at once, in terms of a unit to be adopted similar to the ohm for the conductive circuit. There would not then be nearly so much trouble about the separate resistances of field-magnets, air-space, or armature core. We have the means of making such resistance-boxes in that we can obtain accurately whatever ampere-turns we desire, and a given P (ampere-turns) will give us a given Q (lines of force) through an R (to be agreed upon). We have long wondered why Mr. Kapp or some other practical man has not done this, and there may be reasons against adopting such a plan with which we are unacquainted. From our point of view, however, it would save a lot of trouble in calculation in the design of dynamos. The magnetic resistance of the iron used would be measured. The magnetic resistance of the air space would have to be measured once. It would be known ever after. The total magnetic resistance of the circuit would be known, and the construction of dynamos would become almost as simple as the construction of wheelbarrows. We are inclined to believe that iron would be made to specification like copper is now, to supply the wants of dynamo makers, and probably would be sold with a guarantee of its magnetic resistance being within certain limits. The maker would test samples of each bulk of iron, and invoice the iron out according to the result obtained. It is not for us to suggest a unit, we have too good a knowledge of how the suggested practical units for conductive resistance were tossed from pillar to post and from post to pillar. How many were there before the "legal ohm"? It will be the same again. Whoever has the temerity to suggest this practical unit—unless, indeed, "Crompton" or some other maker will put one on the market—will have Jones, Brown, and Robinson all arguing that the suggestion is bad—can't be worse—and putting their ideas forward as better and far more perfect.

TESTS ON THE EFFICIENCY OF WESTINGHOUSE CONVERTERS.

BY N. MARSHALL.

The following account of tests made at the Massachusetts Institute of Technology, under the direction of Prof. Charles R. Cross, we believe will be of general interest to the readers of the *Electrical World*, as these tests were made with great care and are believed to be quite accurate. They agree to a fraction of a per cent. with tests made on the same converters by different observers and by an entirely independent method. A description of the method employed will be given first, then a description of the apparatus, and the results of the tests will be given finally.

Method.—As all the methods employing electrometers seemed to be very unsatisfactory, a calorimetric method was employed in making these tests, two calorimeters being used—one an ice calorimeter to measure the loss due to conversion and a water calorimeter to measure the output.

When measurements were not being made on the output, it was expended on a bank of lamps adjusted so that the same current would pass through them as through the coils of the water calorimeter; this adjustment was made and maintained by means of a Thomson-Houston current indicator. The change from lamps to calorimeter was effected by means of a commutator and occupied an inappreciable time. Potential was observed by means of a Cardew voltmeter. In making a test the procedure was as follows:

The converter, stripped of its outside casing, was placed in the inner compartment of the calorimeter, the wire led out and all joints made secure against leakage. The calorimeter proper was then packed with ice, its cover was put in place and ice put around the whole, this ice being contained in a non-conducting box, and serving simply as a jacket. When the packing was complete the apparatus was covered and left to stand over night in order to allow all parts to become thoroughly cooled and to assume a uniform temperature of 0deg. C. The next morning the rate of drip from the calorimeter was observed, this observation being taken to allow for melting due to the heat of the room. The current was then turned on for eight hours; during this time frequent observations were made on the rate of output, which was maintained as constant as possible. These observations were conducted as follows:

The temperature and weight of the water in the small calorimeter were noted, the current was then shifted from the lamps to the calorimeter and the time observed to obtain a given rise of temperature, as the current was the same as that through the lamps; these observations gave a means of computing the output. At the end of the eight hours the current was shut off and the apparatus allowed to stand until the rate of drip was the same as at the start; this was generally for about 48 hours after the current was turned off. When this rate was attained it was assumed that the converter was again at 0deg. C. The test was then stopped and the water collected from the melted ice and weighed. This gave, after the correction for the atmospheric melting had been applied, a measure of the loss due to conversion. Having the output, we are able to calculate the efficiency.

Description of the Apparatus—The Ice Calorimeter.—The ice calorimeter is made of three separate boxes or compartments. The outside box is built of 1½in. boards lined on the inside with tin, with an intervening space of 3in. closely packed with sawdust; this box serves merely as a jacket for the calorimeter.

In order that all the water resulting from the melting of the ice may be collected, the sides of the calorimeter box proper are brought to a point, the slope making an angle of about 45deg., terminating in a pipe one-quarter of an inch in diameter. A rubber tube is fitted over this pipe and led through a hole in the bottom of the jacket. To prevent the warm air outside from passing up through into the calorimeter, the tube was allowed to sag and form a U-trap. The tube was furnished with a glass nozzle to facilitate the observation of the drip. The box has a closely fitting galvanised iron cover having two short pipes near the centre through which the leads may be carried. A space of 3½in. is left between the walls of the jacket and calorimeter, which was packed with ice.

The case which is intended to contain the converter is also of galvanised iron, and is of sufficient dimensions to comfortably contain the converter after it has been stripped of its outside casing. The two supports for this case are of iron rivetted to the sides of the calorimeter, to prevent any possible error from conduction along these. Two pieces of wood are interposed between the supports and the case. A galvanised iron cover, similar to the other, completes the ice calorimeter. A space of about 6in. is left between the case and the inside box, which is also packed with ice.

The Water Calorimeter.—The water calorimeter is of tin and made in the form of a cylinder, and contains a little over 13 kilogrammes of water. It is placed in a larger tin cylinder with an air space of 4in. The calorimeter rests on blocks of wood to prevent conduction.

The tin used in making the calorimeter is as thin as possible and the water equivalent is therefore negligible. The wire of the coil is of german silver wound about a wooden frame, the frame itself being held in position by clamps fastened to the sides of the calorimeter. The water was kept in constant circulation by stirring and the mean temperature was maintained as nearly as possible at the temperature of the room, so that on account of the large amount of water used, the cooling temperature correction is about one-tenth of a degree an hour and is therefore negligible as the tests on this calorimeter were only 10 minutes long. The temperature readings were taken with a very sensitive centigrade thermometer graduated to tenths of a degree.

Calibration of the Calorimeter.

The ice calorimeter was calibrated by placing a german silver coil in the casing and passing a direct current through it; the current and potential were read by means of Thomson's stage instruments, and were maintained constant. The calibration test lasted eight hours, the current and potential being kept at such values that the number of watts put through the coil should generate the same amount of heat (approximately) as was given out by the converter during the regular test. Two such calibrations were made, and checked the calorimeter to 1 per cent.

The water calorimeter was calibrated by the same method and checked to three-tenths of 1 per cent. Any error in the ice calorimeter from water adhering to the ice was reduced to a minimum by allowing the calorimeter to stand a sufficient length of time before beginning and completing the test.

Test on Ice Calorimeter.

March 19, 1889.

Coil of german silver wire, resistance	3·11 ohms.	
Current turned on	9h. 10m.	
Current turned off	17h. 10m.	
Tests stopped, March 21	12h. 15m.	
Drip at start, drops per minute	3·8	
Drip at finish, drops per minute	2·7	
Weight of ice melted (uncor.)	17,419gms.	
Drip correction	269gms.	
Weight of ice melted (cor.)	17,150gms.	
Heat units developed	1,372,000gms. deg.	
Average potential defl.	36·3 P., ¼ N.	H = ·1751
Average current defl.	44·3 P., 1 N.	
Number of heat units developed, as shown by Thomson inst's	1,357,776gm. deg.	

Check to 1 per cent.

A second run gave a check to 2 per cent., but owing to an accident was unreliable.

Calibration of Water Calorimeter.

March 13, 1889.

Temperature, start	9·9deg. C.
Temperature, finish	13·6 ,,
Time run	10m.
Weight of water	13,322gms.

Thomson Instruments.

Potential galv. defl.	22·90 P., 1·8 N.
Current	29·35 P., 1·2 N.

Check to 0·3 per cent.

Test No. 1.

May 3, 1889.

20-ampere Westinghouse converter No. 4.

Current turned on	9h. 10m.
Current turned off	17h. 10m.
Test stopped, May 6	9h. 5m.
Drip at start, drops per minute	5
Drip at finish, drops per minute	1·75
Weight of ice melted (uncor.)	6,428gms.
Drip correction	769gms.
Weight of ice melted (cor.)	5,659gms.
Calories lost	452,720
Weight of water in water calorimeter	13,656gms.
Time of run in water calorimeter	10m.
Mean rise of temp., water calorimeter	10·8deg. C
Total output in heat units	7,079,270gm. deg.
Calories per minute	14,747·5
Efficiency	93·9
Lead	20 amperes, 50 volts
Alternations	14,530 per min,

Test No. 2, *May* 7, 1889.

20-ampere Westinghouse converter No. 4.

Current turned on	9h. 10m.
Current turned off	17h. 0m.
Test stopped, May 9	11h. 0m.
Drip at start, drops per minute	3
Drip at finish, drops per minute	1·5
Weight of ice melted (uncor.)	6,671gms.
Drip correction	354gms.
Weight of ice melted (cor.)	6,417gms.
Calories lost	513,360
Weight of water in water calorimeter	13,656gms.
Time of run in water calorimeter	10m.
Mean rise of temp. in water calorimeter	10·7deg. C.
Total output	6,867,602gm. deg.
Calories per minute	14,611·9
Efficiency	93 per cent.
Load	25 amperes, 50 volts
Alternations	14,840 per minute.

Memorandum.—During these tests the primaries of converters were in series with two 16-c.p. Sawyer-Man lamps, as the machine was run at a very high voltage for other work.

Note.—Tests were made at the same time of converters of the two other principal manufacturers of alternating apparatus; the next highest efficiency to the Westinghouse was 84 per cent.

THE SCIENTIFIC WORK OF JOULE.

The first of the weekly evening meetings for the present year of the members of the Royal Institution took place on Friday night at Albemarle-street, when Prof. Dewar, F.R.S., delivered an address on "The Scientific Work of Joule." Sir F. Abel presided.

Prof. Dewar began his address by stating that, as the Royal Institution had always been associated with the great workers of physical science, it was thought that the death of Joule should not be allowed to pass without its recognition. The man who of all others was most competent to deal with Joule's work was, of course, Sir William Thomson, who had been Joule's fellow-worker almost to the last. Sir William had expressed himself desirous of delivering such a lecture before the institution, but had quite recently found it impossible to leave Scotland. James Prescott Joule was born in 1818, and was the second of five sons. His father and grandfather before him owned a brewery, which descended to him and his brother. He was delicate as a child, and his education was carried on by tutors until he was about 15, when he began to work in the brewery. He obtained his first instruction in physical science from Dalton, to whom he went to learn chemistry. He began practical work at a very early age, and before his death had a record of nearly 40 years of constant scientific research. His work was represented by 115 papers dealing with various and complex subjects. The period between 1838 and 1843 was that within which Joule educated himself in experimental methods, and at this time he was principally engaged in the study of electricity and electromagnetic engines. His researches led, in 1840, to the discovery of the true law representing the relation between electric energy and thermal evolution. His great success was achieved by an elaborate examination into the relations of supply of electricity and its distribution, not only in the conductors exterior to it, but also in the battery cell itself. This law, which seemed so simple, was of the greatest importance. It was that the amount of heat produced by a given amount of electric current varied as the square of the intensity of the current and directly as the resistance, always provided that a given unit of time were used. Joule saw that this was easily proved in a relative degree, but to account for the whole of the distribution of the current was more difficult. This led him to the study of electrolysis; and it was marvellous that, with the great difficulties which the method presented, he was able to discover all the impediments to an electric current, and to prove conclusively that the whole distribution of energy could be accounted for. In 1841 he had practically completely analysed the distribution of energy in the electric current; and he had discovered the law regulating the distribution of heat in all parts of it. In 1842 he had really his great discovery in hand, as was shown by a footnote to a paper written on January 25, 1842. It seemed extraordinary that always the most difficult and complex methods of dealing with a subject were at first taken; and to anyone who read Joule's paper on the determination of the mechanical value of heat by means of an electric current, it seemed astounding that he should ever have overcome his difficulties. To produce a thermal effect was easy enough; but the difficulty was to prove the permanent and persistent relation between the energy expended and the heat produced through the electric current. There were the fluctuations of the current, the effects of radiation, the movements of the air, and other circumstances to be allowed for; and Joule had to depend on very small variations of temperature, using, therefore, very delicate thermometers. By the end of July, 1843, Joule was able to state the quantity of heat capable of increasing the temperature, of a pound of water by 1deg. F., and that was equal to, and might be converted into, a mechanical force capable of raising 770lb. to the perpendicular height of one foot. After his first determination of the mechanical equivalent of heat, he stated that he had arrived at a nearly similar determination by a more direct method—namely, by the friction of water passing through small tubes. In all great scientific discoveries it was difficult to distribute merit exactly. There were those who, while admiring the broad and rapid generaliser, could not understand the patient and plodding experimentalist. Joule never pretended to be anything else but an experimentalist. He would go step by step through intricate masses of work and research and never generalise until he was perfectly sure. It was difficult to know how it was that Joule's great discovery had not been anticipated. Rumford, who first clearly defined the relation between the constant production of heat and the loss of motion from friction, went near to doing so. Humphrey Davey continued Rumford's experiments in a different manner, and entirely dissipated the idea of the separate existence of caloric; and Young did much in analysing the position. After 1843 Joule several times, up to a late date, made fresh determinations of the mechanical value of heat, on each occasion varying his methods and ever reaching nearer to exactness. Thus in 1878 he stated that he found that 1lb. of water would be raised in temperature 1deg. F. by 772·55 foot pounds of work. Besides the work on his mechanical equivalent, Joule was conducting in the forties elaborate investigations on the maximum density of water, specific gravity, and atomic volume. Joule's last research was long and laborious, extending over a period of nearly ten years, and was conducted with Sir William Thomson. The one subject of their research was the study of gases passing through narrow apertures, and the other the study of the velocity of bodies through air, and the temperature the bodies would ultimately attain by moving through air. They found, in the former subject, that, instead of the product of the pressure and volume of gases being proportional to the absolute temperature, a new term was needed—a constant, multiplied by the temperature and divided into the volume. Thus they were able to enunciate what must be called the true gaseous law. In concluding his address, Prof. Dewar said that it was impossible adequately to deal in a lecture with the life work of a man like Joule. Everyone must be interested in hearing of the man as well as of his work, and therefore he had asked Sir Lyon Playfair, Joule's sometime fellow-worker, to give him some reminiscences of his dead friend. In reply, Sir Lyon had written as follows: "You ask for some of my memories of Joule from 1842 to 1845, when I was Professor of Chemistry at the Royal Institution in Manchester. The great Dalton died in the autumn of 1844, and had long been president of the Manchester Philosophical Society. He naturally gave impulse to the study of science in that town, where there was an active band of young workers in research. Joule was, even then, foremost among these; and the names of Binney, Williamson, Schunck, Angus Smith, Young, and others show that the spirit of scientific enquiry was active. We were also stimulated by the fact that Baron Liebeg and Bunsen came to pay me visits during that time. They were men to excite research. Joule was a man of singular simplicity and earnestness.

We used to meet at each other's houses at supper to help the progress of our work by discussion. Joule was an earnest worker, and was then engaged upon his experiments on the mechanical equivalent of heat. He took me to his small laboratory to show me his experiments, and I, of course, quickly recognised that my young friend the brewer was a great philosopher. We jointly worked upon questions of far less importance than his great central discovery, but he was equally interested. I was very anxious that he should devote his life to science, and persuaded him to become candidate for the professorship of natural philosophy at St. Andrews. He was on the point of securing this, but his personal slight deformity was an objection in the eyes of one of the electors, and St. Andrews lost the glory of having one of the greatest discoverers of our age. When Joule first sent an account of his experiments to the Royal Society, the paper was referred, among others, to Sir Charles Wheatstone, who was my intimate personal friend. Wheatstone was an eminently fair man, and a good judge, but the discovery did not then commend itself to his mind. For a whole Sunday afternoon we walked on Barnes Common discussing the experiments and their consequences, if true, to science. But all my arguments were insufficient to convince my friend; and I fear that then the Royal Society did not appreciate and publish the researches. I write from memory only, for I know that later no society or institution honoured Joule more than the Royal Society and its members. Not for one moment, however, did Joule hesitate in the accuracy of his experiments or his conclusions. He once suggested to me that we might take a trip together to the Falls of Niagara, not to look at its beauties, but to ascertain the difference of temperature of the water at the top and bottom of the fall. Of course, the change of motion into heat was a necessary consequence of his views. No more pleasant memory of my life remains than the fact that side by side at my lectures in the Royal Institution used to sit the illustrious Dalton, with his beautiful face, so like that of Newton, and the keenly intelligent Joule. I can give no other explanation than the fact of organic chemistry being then a new science that two philosophers of such eminence should come to the lectures of a mere tyro in science. I used to look upon them as two types of the highest progress of science. Newton had introduced law, order, and number into the movements of masses of matter in the universe; Dalton introduced the same into the minute masses which we call atoms; and Joule, with a keen insight into the operations and correlation of forces, connected them together and showed their mutual equivalence. I do not know whether these memories are of any use to you, but such as they are, they are at your disposal for your lecture on the friend of my youth." —*Times.*

LONDON CHAMBER OF COMMERCE.

A meeting of the Electrical Trades Section of the London Chamber of Commerce was held on Monday afternoon at the offices of the Chamber, Botolph House, Eastcheap, Mr. R. E. C. Crompton in the chair. The Electrical Exhibition at Edinburgh first occupied the attention of the meeting, and the chairman said the trouble the section had taken in the matter had not, so far as he could learn, resulted in very extensive action being taken by the electrical firms, few acknowledging the soft impeachment of exhibiting, a proof of the surfeit of such exhibitions. The French Government, it was mentioned, are intending to encourage exhibitors from that country, and will pay all expenses of transport, a fact which might induce English firms to do their best. Special terms had been sought for electrical firms, but this had resulted in similar terms being granted to all. It was resolved, on the motion of Major Flood Page, to ask the exhibition authorities to send a list of intending exhibitors before taking further action.

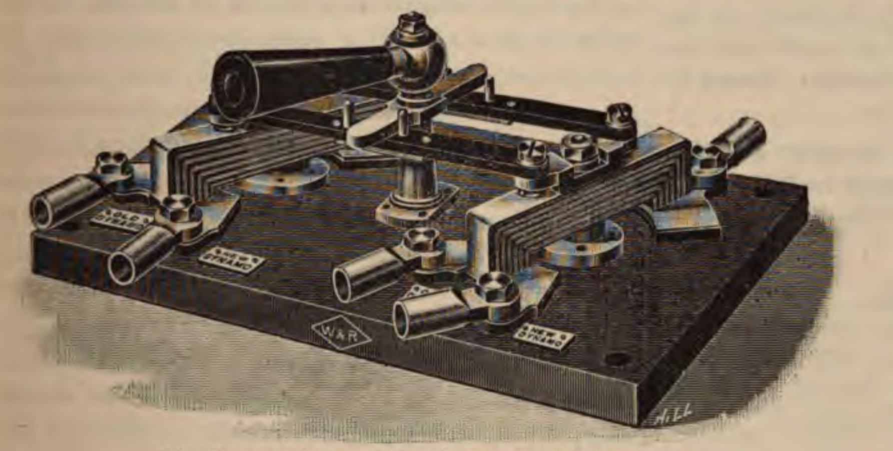
The question was then discussed of the universal adoption by the electrical trades (and so finally, if possible, by all allied trades) of the British Association screw gauge for screws of ¼in and less—that is to say, for sizes below the *now* standard Whitworth thread. It was stated that the gauge was in reality the Swiss gauge introduced by Prof. Thury, and practically the same (but for finish of thread) to the American gauge. The matter was strongly urged by Mr. Crompton as important to the whole trade. A committee was appointed, consisting of Mr. Crompton, Mr. Swinburne, and Mr. Evershed, who, together with the secretary of the section, Mr. Trotter, would find out by circular the sizes and shapes of screws usually employed by manufacturers, who would forward an envelope full of the nearest sizes, in standard gauge, for the manufacturers to see if these who suit, and would undertake to acquire 25 or 100 sets of standard screwing gear to be supplied to the various firms at cost price, on their sending in their adhesion. The question of the blocking of provisional orders by local authorities was dropped. Some discussion afterwards took place on the question of county council surveyors and their dispensing powers. The difficulties in the way of electrical lighting companies in establishing central stations was alluded to. It appears that since the abolition of the Metropolitan Board of Works, sundry dispensing powers of the surveyors with regard to the Act have been rescinded. No building can be built of over 216,000 cubic feet, a regulation which the London Supply Company have avoided by a special clause in their Act. End walls of a temporary character where extension is contemplated must be equally of brick and well built as if for permanent use, instead of sheet iron or other means being allowed. Worksheds cannot be erected except in brick—a regulation which has led to contractors' sheds being on wheels and so technically "carriages;" roofs must be of a certain pitch, and no living-rooms may be constructed over a workshop or warehouse—a regulation greatly restrictive in the case of central stations. The present law hardly touches jerry-building, but harasses at all points anyone who is wishing to carry out useful and good work. Major Page moved and Mr. Wharton seconded the following resolution: "That the chairman of this section be requested to draw the attention of the council of the Chamber to the inconvenience to this section of the Metropolitan Building Acts with a view to their consulting all the trade sections interested in the matter, with the ultimate intention, if the council approve, of bringing the subject before the London County Council." The resolution was unanimously agreed to.

Mr. Crompton then broached what he termed his pet idea of a bureau of useful information. He wished to see how far the electrical supply companies could combine to compare information which should be useful to all alike. There was no doubt that in certain trades, such as the iron trade, there was practically free trade in ideas. It was too much to hope that all the companies would throw open their information to the same extent, but he thought something might be done in a similar direction. It was true that a person might obtain a good deal of information by studying the Board of Trade returns—the amount booked to the actual manufacture and supply of electricity was given, but not how it was made up. He would ask for this information and analysis from the various companies. Some would refuse, but it would be distinctly to everyone's benefit to see the price of so to speak "manufacture" of electricity, and eventually everyone would benefit enormously. Some would see they were burning too much coal, some the salaries were too high, or the loss in the system of distribution too much. There were no doubt immense difficulties in the way, but he might say he had already obtained most of this information for himself. In America the Central Edison Company obtained the returns from all the subsidiary companies, and Edison had already mentioned his willingness to co-operate. In America and in Germany they should have sub-sections. In answer to objections by Major Flood Page, who said he thought the companies would object to giving more information to the Chamber than to their shareholders, Mr. Crompton strenuously pointed out that the actual cost of manufacturing was a very small proportion of the whole cost, including management and legal expenses, and it was these that determined the dividend. In fact, it had been found in the iron trade that the information given to the Iron and Steel Institute of the amount of coal per ton melted, etc., gave no guide to the standing of the companies, and was not objected to by them. What was desired was particulars of the efficiency of the mechanical part of the business, of the engines, boilers, dynamos, and transformers, without the trouble of wading through undigested reports and facts. These points were not a question for the Institution of Electrical Engineers, before whom he had already raised it; they had definitely and properly refused to discuss commercial aspects. A platform for the commercial aspect was necessary, and he thought the Chamber of Commerce was the proper body. After some further discussion, Mr. Crompton was requested to draw up a circular letter to be submitted at the next meeting of the section.

THE WOODHOUSE AND RAWSON DOUBLE-POLE TWO-WAY SWITCH.

Our illustration shows a new form of switch which is likely to find favour with those who advocate the double-pole arrangement of switches, and its construction contains one or two interesting novelties.

It will be seen that the brushes are built up in a somewhat different way to the well-known multiple brush hitherto employed in the switches of Woodhouse and Rawson—they are given a still greater individuality of movement by separating each part from the adjacent one, with a washer in the centre, and for simplicity of construction they are made with square corners in place of round.



Woodhouse and Rawson Double-Pole Two-Way Switch.

The crossbars which connect the two brushes are of vulcanite, which possesses sufficient strength and the necessary elasticity and insulating properties. The method of attachment for the cables is the very convenient movable socket-form into which the cable is sweated.

The switch appears to be exceedingly well designed for the class of work now in common demand for the management of heavy currents, where a thoroughly good contact combined with the double-pole break is desired.

COAD'S BATTERY AND MINERS' LAMP.

Quite a numerous assembly of Press representatives met at 31, Soho-square to inspect Mr. Theophilus Coad's new electrical inventions, and many florid notices accordingly appeared in the papers of the next morning, the *Daily News* even going so far as to suggest that possibly Mr. Coad had found something which might eventually rival the central station systems it has so picturesquely described. We have no wish to belittle any labours of Mr. Coad, but when an inventor brings forward a new primary battery—the solution of which is "kept a secret," "the cost is one penny per hour"—we think how often have we heard all this or something like it before, time and time again, and where, we ask, are these wonderful batteries now? We want something more definite than the secret solution, and the overrun 2-c.p. incandescent lamp and vague statements of 1d. per hour, to be absolutely assured that we have pre-eminently the battery of the future, which may be made a basis of proposals for forming companies for which the public are to be asked to pay. With this general preamble, which seems to be necessary, more perhaps for untechnical than for technical readers, we are pleased to give the following particulars of Mr. Coad's exhibits.

These consist of three things—a new battery, a safety miner's lamp, and a refracting concentrating lens. The battery is the usual zinc and carbon arrangement, and has the advantage of being a single fluid battery. The solution is a fluid, constitution not stated, of strong antipolarising nature, so much that the battery is stated to be able to burn without diminution of light for 12 hours. It is mounted in an unusually small space, as the fluid can be used to the last. The zincs are stated to wear away very evenly right to the thinness of paper. The connections are made in a very simple manner, this being one of the points of the patent. All screw terminals are done away with, and the connection is made by simply a plug of indiarubber or ebonite, which forces the plates apart and keeps them pressed against two platinum studs projecting through the partition between the cells. The zincs for a miner's lamp will last a week of eight hours a day, the solution being simply poured out and refilled every day.

The miner's lamp has an ingenious safety arrangement, and seems, so far as we can judge without practical experience, to fulfil many of the necessary conditions of success for an electric miners' lamp. It is arranged so that in case of any accident to the lamp the current shall be immediately broken. The lamp is arranged in an air-tight case composed of a thick front glass or lens and a flexible metal back. When this is filled with compressed air the flexible back is distended and makes contact with a stud. If the exterior glass is accidentally broken the air escapes, the contact is broken, and the lamp is put out before any chance of explosion is given.

The lamps are fitted with a special lens, which is designed of such a form as shall greatly intensify the strength of the light in a certain direction in the manner of projector reflectors for search-light. Instead of being a parabolic reflector, however, it is a parabolic lens, of a curved pyramidal shape, flat at the back and projecting to a point, polished in facets which have as near as possible a parabolic curve. The result is that a fairly strong beam of light is thrown straight forward, even from an incandescent lamp of ½ c.p. The lamps used in the Coad's miner's lamp have been made specially by the Edison and Swan Company for these lamps, and are arranged with the connections sideways on the bulb, so that the glowing filament is presented sideways instead of endways as usual. The miners' lamps are fitted in neat ebonite boxes, with straps and screws to easily allow of inspection and refilling.

The battery was shown in use for other purposes, as applied to ordinary room lighting and for carriage lamps. A larger self-contained battery and lamp, furnished with a silvered reflector, is intended for coastguard work, and is fitted with a simple flashing apparatus for signalling on dark nights. Mr. Coad has evidently given considerable attention to the adaptation of primary batteries to useful purposes. We are not able without sufficient data to give an absolute opinion upon the possibility of their practical extension, for the question of cost on actual usage principally decides the industrial development. If the apparatus upon introduction and constant use proves to be economically marketable we shall be most pleased to welcome its success.

Ferranti Mains.—The laying of the Ferranti mains from Deptford is to be undertaken at once. The work will take about nine weeks to accomplish.

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We may occasionally follow the lead of our American Contemporaries, especially when they point out a serviceable way. They are not backward in asking their friends to do all they can for the welfare of the paper. We ask our friends to remember us. No paper that we know ever refuses Subscribers or Advertisers. Nor do we; in fact, we invite them, believing that they will get full value for their money.

Specimen copies of the paper will be sent on request.

LOCAL AUTHORITIES.

As most of our readers are aware, one of the subjects for discussion at the meeting of the Electrical Section of the London Chamber of Commerce last Monday, was to consider the action of local authorities in seeking for provisional orders. Fortunately for the section, the discussion practically fell through, and so for the present criticism adverse to the local authorities is withheld. The reason alleged for obtaining action of the Chamber of Commerce is that some local authorities are seeking provisional orders merely for blocking purposes. They do not intend to do work themselves, and mean to stop anyone else doing work. We are not commissioned to defend the local authorities, although our connection with such authorities is perhaps more extensive and more intimate than that of all the electrical engineers combined. It is no news to many that we have consistently advised local authorities to fight exceedingly shy of electrical fishing companies. By fishing companies we mean syndicates or companies whose principal objects are to float other local companies, clear out themselves with as good a haul of promotion money and as many founders' shares as they can lay their hands on. Let us digress for a moment in mentioning founders' shares. A wealthy man recently asked our advice as to his investing some money in a large London company. We gave it, and it was the same as *Punch's* to those about to marry—don't. Subsequently talking over the matter, we found our friend made a practice of never investing where founders' shares existed, and therefore had our advice been otherwise he would not have acted upon it, as the promoters of this company had "founders' shares." Most of our readers would be surprised to know how prevalent this feeling is, and if it was generally realised how little the public has responded in investing in one or two of the recent big concerns floated by men who are supposed to control millions, the underwriters of the large amounts of capital would have a bad time of it. All their ingenuity has been taxed to push up prices so as to unload, and they hope to come well off by floating a couple of other concerns and realising another lot of promotion money. If Samuel was to beware of "widders," much more should investors beware of "founders' shares." A large and prosperous company, which held its meeting the other day, finds this class of share such an incubus that a company is to be specially formed to buy out the "founders' shares." This digression past, the original text may be resumed. In our opinion local authorities should have the control of roads, sanitation, water, and artificial light in their own hands. There will be little divergence of opinion as regards the roads and the sanitation, but a good deal as regards the water and the light. We admit that our opponents may have tolerably good reasons for their opinions, and only claim a privilege in the "right to differ." In previous articles the arguments have been put forward that the local authorities can do the work better and cheaper themselves than it can be done by any company. The doing the work by the local authority is an action of true co-operation—of true socialism, if that is liked better. No one has attempted to reply to these arguments, except by a general statement that local authorities are slow to move; they need urging onwards; if left to themselves they will sleep the sleep of Rip-van-Winkle, and the nation will progress backwards at a rapid rate. This is all moonshine. The members of many of our local authorities are as well calculated to understand the necessity for go-aheadness as the members of directorates of companies. Take our manufacturing centres. Have not a fair sprinkling of manufacturers sought information as to lighting? have not a fair number adopted it, and are not many more likely to adopt it? During a recent visit to such a centre, we heard words of commendation of the light again and again from men "who intend to instal." Every man is not going to jump at a new idea. There are hundreds of reasons why its introduction should be gradual. Well, these men largely constitute the leading spirits of the local authorities in their districts, and if they view the light in so satisfactory a way for themselves, they must more or less understand its value for the community generally. They do; but they are not the men to be bullied or blustered into undertaking the work immediately. They have to think of ways and means. They have already another light in possession, and it has to be treated with respect. It may well be, then, that a locality threatened by half-a-dozen companies or syndicates, neither of which means work itself, only floating a local company to do the work—we say it may well be that the authorities in such localities will deliberately, and with no intention to go immediately to work, proceed to obtain a provisional order. Can anyone in their sober senses blame them?

Then we have other reasons why the local authorities should step in. Take such a case as this. The local people, not the authority, have interested themselves in the light, have had small and large meetings, have made enquiries of manufacturers as to cost, have perhaps had a rough specification of the work required drawn up, have, after once communicating with them, been kept well warm for action by the manufacturers, when, lo! a syndicate of utter strangers comes forward with an attempt to get a provisional order for this place. Those inhabitants who have interested themselves in the matter, and have become acquainted with the manufacturers, are not likely to be allowed to turn their eyes favourably to the strangers, so there arises two camps, perhaps more, till the best solution of the difficulty is for the local authority to step in and take the "oysters," leaving the shells to the competitors. That is hard for the original manufacturers, perhaps, but the fault rests entirely with those whose object in life seems to be an utter lack of seeing when and where they are not wanted. Broadly speaking then, we do not for a moment believe there are local authorities getting provisional orders of their own initiative solely with the intention of "never doing the work and never allowing anyone else to do it." There may be such, but the number is small. With the examples of Bradford, of Taunton, of Bath, and of other places before us, we have no fear that the real obstruction will come from the local bodies—it will be traceable elsewhere. Again and again has the warning come to be satisfied with the ordinary progress, and not attempt to storm the kingdom in a year. The policy is wrong, and will lead to trouble. It will be time enough to interfere with local authorities when it is conclusively proved that they are obstructionists to the introduction of something that will be of great advantage to their constituencies if introduced. Even then the proper course to pursue will be to educate the constituencies, who can any year remove objectionable men, replacing them by men of more light.

LITERATURE.

Electric Light Installations and the Management of Accumulators. By Sir DAVID SALOMONS, Bart., M.A. New edition, revised and enlarged. Whittaker and Co., London, 1890.

It has been our duty to notice previous editions of this book, and to point out what we considered its peculiar features rendering it valuable for general consultation. In the first place, this is the only book that really touches upon the practical use of accumulators, and we all know how greatly their use has extended, and is extending, in electrical engineering. We have other books telling of the supposed or ascertained chemical actions that go on; but unfortunatley such learned books are of little service to those who have charge of accumulators. The man in charge cares nothing about sulphates or oxides, or strength of solutions, except to know how high or how low his acidometer should stand when the cells are charged or discharged. As a matter of fact, to work with a man who knows a lot of book and laboratory science is impossible, or rather uncongenial. He is full of doubts and fears, he wants to take all manner of precautions, whereas the man who has more practice and less science rubs along splendidly. You tell him what he is to do, he does it, and, as a rule, the result is fairly satisfactory, while the other man ponders, thinks you have forgotten something, and waits further orders. This book is for the practical man with a little science, and for him it is good. The information has been obtained by a careful study of the apparatus in use at Broomhill—Sir David Salomon's residence, near Tunbridge Wells. This installation is not the result of the whim of a rich man; it is intensely practical. It has this advantage, however, that the owner is in a position to test improvements. How this has been done will best be understood by a few extracts. In 1874, lighting was tried with primary batteries. In 1881, a 16-candle Jablochkoff dynamo was installed. In 1882, an accumulator was sent to Broomhill; in which year also a Siemens machine replaced the Jablochkoff. This was replaced in the early part of 1883 by another Siemens dynamo. Another change was made in March, 1883, and in the autumn of that year the introduction of accumulators for lighting purposes "proved a great blessing." A further change resulted from the desire to have a model installation; this was done in 1884. It will not be necessary to trace the extension that continued, except to say it includes four dynamos and about 30 motors. "A cost book has been accurately kept since 1884," but for all this important information we must refer to the book itself. We have referred to these details to show that our contention is correct, the statements made in the book being from practical experience and not evolved from the inner consciousness of the author.

The book treats of the various parts of an installation, paying particular attention to the accumulator. It has always seemed to us that the work of Faure in connection with secondary batteries has been misjudged. Just at a time when everybody was crying out for the need of something in electric light apparatus analogous to the gasometer, we suggested an old plan. Sir William Thomson's letter to the *Times* set the ball of praise rolling, and now Faure is the accredited designer of the modern accumulator. We should dub him the resuscitator. The author refers to Mr. Fitzgerald's lithanode. We have before us an article of Mr. Fitzgerald's written and published in 1863, some years before Faure was known in connection with secondary batteries, in which the following remarks occur: "The great power of the secondary combinations we have referred to is due to the presence of the peroxide of lead in contact with the negative element in these combinations." Further on he suggests a couple of "a negative element of platinum, *surrounded by a mixture of dilute sulphuric acid and the peroxide of lead*, and for a positive element an amalgamated zinc;" also "where lead instead of platinum is used for the negative element." Again, "And as the peroxide of lead is somewhat difficult to obtain by chemical means, and nitric acid is expensive, it may often be convenient to utilise the current from any small battery we may have at hand in the production of more powerful combinations." The article then goes on to describe "charging" and "discharging." This is not the only reference of the value of the peroxide of lead in secondary batteries about that time, but it must be remembered that experimentalists had no developed dynamo to use, nor had they the incentive to produce a battery for electric lighting. Their experiments were merely experiments, but with no goal in sight. We remember—but fail for the moment to put our hands upon the reference—reading some printed correspondence relating to secondary batteries in the early part of the sixties in which the peroxide of lead *v.* lead in secondary batteries was clearly discussed. We should have mentioned that Mr. Fitzgerald had in his article previously discussed Planté's lead *v.* lead cell, and the suggestion peroxide of lead and amalgamated zinc is as an improvement. Faure is to be congratulated with having resurrected these older views at a time when public excitement ran high. Probably De la Rue ought to be credited with the suggestion of secondary batteries with peroxide of lead. We have made these remarks simply with a view to throw a little light upon a subject not much understood. The book does not pretend to furnish a history—its purport is practical suggestions, and of these there are many and valuable. One little bit of information will gladden users of incandescent lamps. "With the perfect methods of governing in operation at Broomhill, whereby the variation of pressure is limited to 1 per cent., the lamp life approaches, if it does not even exceed, 3,000 hours, so that the replacing of an old lamp by a new one becomes a 'red-letter day.'" There is one point in connection with the life of lamps upon which we should like to have Sir David Salomon's experience. A new lamp is placed upon the circuit, and it gives its normal candle-power. This candle-power is decreased frequently by a more or less slight blackening of the globe. Is the lamp condemned only when the filament breaks, or when the candle-power deteriorates below a certain quantity? A lamp may last before the filament breaks for 3,000 hours, but is it approximately similar in candle-power at the end to what it was at the beginning? We advise every man who has to do with installation work to study this book.

THE ELECTRIC LIGHT AT THE BRITISH MUSEUM.

It was with considerable pleasure, both from the ordinary sightseer's or the archæological point of view, as well as from that of the electrical engineer, that we joined the throng of persons who were invited on Monday evening to inspect and welcome the introduction of the electric light in the vast galleries of the British Museum. These have hitherto been closed to the public after dusk, or invisible upon foggy days, a matter of constant regret to those who have wished to see the general public admitted to view or study the national treasure-house. On account of the risk from fire it has been impossible to introduce artificial illuminants, until electricity came to the rescue and provided a suitable, safe and cleanly means. In the early part of last year Mr. Molloy, M.P., pressed the question of the adoption of the electric light in the British Museum in Parliament, and in spite of a considerable amount of opposition—which really seems almost inexplicable in view of the utility—the House sanctioned the expenditure of £5,000 for lighting other rooms and galleries in addition to the reading-room, till then with its approaches the only part lighted. This has been carried out in extension of the original installation, and the lower galleries of sculpture and Egyptian antiquities on the ground floor, and the porcelain, mediæval, Asiatic, Japanese galleries, the mummy-room, and the gallery of uncivilised tools and implements shone brilliantly under the blaze of the electric light, while crowds of the most distinguished in science, art, literature, law, and the Church—some 3,000 in all having been invited—wandered, chatted, and admired the treasures in their new light. The lamps are arranged in two methods, both arc and incandescent being employed. The arc lamps generally are hung close under the roof, and distribute a soft, brilliant, and steady light: in the sculpture gallery these have a particularly good effect, giving a crisp and clear appearance to the statues. In some of the long galleries the incandescent lamps are ranged in long rows close together and near the ceiling, with little porcelain reflectors above each, the bare copper strip being run from end to end. Porcelain switches, to be turned only with a key, are fixed upon the walls at the ends of the galleries. The light is full and ample, and remarkably well distributed.

The public galleries on the ground floor are lighted with 69 arc lamps of various powers, while on the upper floor there are 57 arc and 627 glow lamps. In addition to these there are five large arc lamps in the reading-room, six in the courtyard, and upwards of 200 glow lamps in the offices and passages. The total current required to work the whole of the lamps is nearly 1,200 amperes, with an E.M.F. of 115 volts at the lamp terminals, and this output is produced by the expenditure of nearly 200 brake horse-power. The current is generated by four Siemens dynamo machines, each capable of giving an output of 450 amperes and 130 volts, which are connected to a general switchboard in the engine-room by means of which they can be put to work in parallel to any or all of the circuits. The switchboard is fitted with instruments indicating the current given off by each dynamo, and four circuits are led from it round the Museum—two for the upper and two for the lower floor. The main wires are laid outside the building. In order to ensure safety and to guard, as far as possible, against failure of light, the motive power is in duplicate. The four dynamos are driven in pairs, each pair by a separate engine with a separate countershaft. Each engine has a separate steampipe in direct communication with the boilers, and there is an ample reserve of boiler power. The power of the engines and dynamos is so adjusted that each of the two sets is capable of working the whole of the lamps in those galleries proposed to be lighted on any one evening; the other set standing by ready to work. Further, in order to work, if required, at half-power, or in order to provide half-light for the whole of the galleries—which light should suffice for an emergency such as sudden fog or accident—the lamps are connected in pairs alternately, so that half of the number being cut off, the light of the other half still remains evenly distributed. The engines have been supplied and erected by Messrs. Marshall, Sons, and Co., Limited, of Gainsborough, and the electrical work has been executed by Messrs. Siemens Bros. and Co., Limited. The installation has been carried out under the supervision of Mr. W. H. Preece, F.R.S., who acts as consulting engineer to the trustees of the British Museum.

On the day of inspection, the reading-room was closed and the available power was used for both east and west wings. The installation, however, is not at present sufficient to run the whole, and in addition to the reading-room, as at present it is intended to run the east and west wings on alternate days up to ten o'clock at night. It is a pity while the work was contemplated that it was not carried out in its entirety, but this will come. The authorities and the engineers may be congratulated in combining to obtain a most complete and satisfactory success, and all who were present on Monday were unanimous in praise and hopeful of the immense added usefulness.

BATHURST'S IMPROVED BACK BLOCK.

We illustrate an improvement on the details of house installation work brought out by Mr. F. Bathurst, being an improved form of back-block for brackets, switches, cut-outs, or ceiling roses. In the ordinary block, consisting of one solid piece of wood, this has to be grooved by the workmen when fixing to fit the wires, and the wires themselves lay next to the wall or plaster. In the new form of back-block there are two pieces of wood; the lower one (which can be of cheap soft wood like the casing) is first fastened to the wall. In this the grooves for the wires are already made, and the top block can then be fastened upon this, both saving time in fixing and effectually keeping the wires off the wire or plaster. The cost is only 25 per cent. above that of the old block and makes a far better and more workmanlike job, besides the electrical advantage. It would be as well for the manufacturers of wood blocks and electric contractors to investigate the advantages of this improved form.

THE STANLEY CONSTANT-CURRENT ALTERNATING MACHINE.

With the constantly increasing application of the alternating system, and its adaptation to all purposes for which the continuous current is employed, it is evident that a constant-current alternating machine will find more than one application. The problem involved in the construction of such a machine is the providing of means by which the alternating current generated by the machine shall remain constant under all loads; or, in other words, by which the potential generated shall be approximately proportional to the load. This has been accomplished in an alternating machine by Mr. Wm. Stanley, jun., whose work in this field is already known to our readers. The engraving, Fig. 1, shows the machine in outline, from which it will be seen that it does not differ essentially in form from the alternating machine already in existence. The field-magnets of alternate polarity, N, S, are excited independently, and the armature has polar projections with laterally projecting lugs.

The essential feature of the construction lies in the nature of the windings on the armature poles. These coils consist of many convolutions, so that a slight variation in the quantity of current flowing through the coils produces considerable variation in the ampere turns.

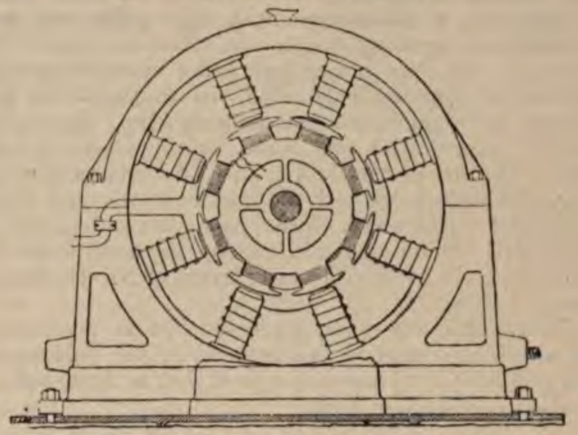


Fig. 1.—Stanley's Constant-Current Alternating Machine.

In the operation of the machine, according to the inventor, the strong field-magnets tend to develop a large number of lines of force, and the alternate current generated tend to set up in the armature core lines of force which oppose or stem back a portion of the lines of force of the field-magnet pole toward which it is moving, thus permitting only a comparatively few to be effective in generating an E.M.F. in the armature coils. These two tendencies to establish lines of force may be considered as the magnetic potentials of the field and armature. The excess of the magnetic potential of the field above that of the armature at the time when the field poles are effective in sending lines of force through the armature core is that which is effective in producing E.M.F. in the armature coils. The number of lines of force resulting from this difference of magnetic potentials, and which are thus effective in developing current in the armature coils, will remain approximately constant so long as the resistance offered to the flow of the current on the work circuit remains constant; but as the resistance increases, the tendency of the armature current to be diminished will allow a great number of lines of force to cut the armature coils, thus increasing the E.M.F. sufficiently to hold the current approximately at a predetermined value.

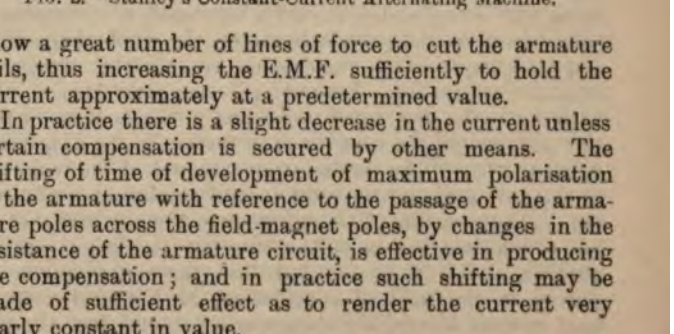


Fig. 2.—Stanley's Constant-Current Alternating Machine.

In practice there is a slight decrease in the current unless certain compensation is secured by other means. The shifting of time of development of maximum polarisation of the armature with reference to the passage of the armature poles across the field-magnet poles, by changes in the resistance of the armature circuit, is effective in producing the compensation; and in practice such shifting may be made of sufficient effect as to render the current very nearly constant in value.

In order to obtain the full effect of the counter influence of the shifting of time of maximum magnetic potential of the armature, the lateral flanges or lugs are provided. These encompass such a portion of the armature periphery as to afford a more or less perfect path for the lines of force of the field-magnet from one pole to its neighbour when in certain positions of the armature, as shown in Fig. 2. It is evident that by this construction a less displacement of the phase of the armature magnetisation is necessary in order to produce the required opposition to the field magnetic potential to stem back the lines of force and prevent them from threading the armature coils.

In practice, Mr. Stanley has obtained excellent results by employing a field-magnet with eight poles and with a cylindrical opening $15\frac{9}{16}$in. in diameter, and 11in. in length, the core projections being about $3\frac{5}{8}$in. thick and having their ends bevelled, the width of the face between the edges of the bevels being $1\frac{3}{4}$in. These poles are each wound with 588 turns, making a total of 4,704 turns. The size of wire is No. 11. The armature is also made with eight poles, and is $10\frac{1}{4}$in. in length and $15\frac{3}{8}$in. in diameter. The width of the pole cores is 3in., and the lugs project 1in. on each side, making the total width 5in. The poles are wound with seven layers of No. 16 wire, 23 turns per layer.

This machine was run at 1,425 revolutions per minute, and with a current of $5\frac{1}{2}$ to 6 amperes in the field-magnet coils yielded 9 or $9\frac{1}{2}$ amperes at an E.M.F. of 3,800 volts.—*Electrical World* (New York).

PREDICTION OF WEATHER.

M. Luigi Palmieri, the learned director of the observatory of Vesuvius, has made himself a specialist in questions appertaining to the electricity of the earth. For some forty years he has studied this question, and has published various papers and more than a hundred notes or memoirs. Unfortunately for science, he has thought well to publish them not only in Italian, but in local papers having naturally a restricted circulation. Dr. Albert Battander gives in *Cosmos* of 25th January a *resumé* of the results obtained by M. Palmieri, which bid fair to prove of considerable importance, if not in the field of electrical engineering, in that of meteorology and the prediction of weather. M. Palmieri indicates first, that the potential of objects which exceed the height of the surrounding earth differ from it in sign, in fair weather being negative, and positive only when rain, hail, or snow fall within a certain distance of the observations. Secondly, the electricity of objects exceeding in height the surface of the earth is not their own, so to speak, but is due to the induction of the atmosphere. He indicates, for example, that if Vesuvius were negative while Naples below were positive, and this were due to different disposition of electricity on their surfaces, the two would tend to flow together and equalise, whereas this is found not to be the case The electricity is therefore due to induction and is so maintained while the inductive influence is steady, changing as it changes M. Palmieri has repeated his experiments some thousands of times since 1850 in varied manners to eliminate errors, and he satisfactorily proves that the electricity of the air is contrary in sign to that of the earth. The electricity of the earth is positive and that of the air negative. He gives two experiments showing the influence of the natural changes in the atmosphere. A platinum cup, filled with water and thoroughly insulated, is connected to the plate of condensor electrometer, the whole exposed to the sun's rays. The evaporation reveals the presence of negative electricity. Inversely, if the same cup is filled with snow, the dew which is formed produces signs of positive electricity: the conditions of success in the experiment being the use of the condensor, on account of the feebleness of the potential, and the most careful insulation of platinum cup. The question of the effect upon the electricity of the air, of plants, trees, or of the sun, has also been carefully studied, and if it is objected that these discussions are purely in the field of speculation, M. Palmieri responds that in these electrical indications we should feel the most sure means of the prediction of weather. In fact, according to the director of the Vesuvian observatory, we must discard our old friend the barometer as the indicator of weather changes which cannot achieve more than 80 per cent. of success in prediction, and take the electrometer, which never is found in default. He argues for the extension of electrometer observations at numerous stations with instruments standardised to the same measure, adapted with methods of testing the varying layers of atmosphere, and believes the time of absolute prediction of weather to be no longer an unrealisable utopian dream.

1889.

Messrs. J. G. Statter and Co.—Of the principal improvements in the manufactures of this firm made during the year 1889, the following may be noticed: For large machines for low and moderate tension they adopted the single circuit field-magnet, made entirely of wrought iron machined all over. These machines are provided with drum armatures and are ventilated; they have been so successful in point of freedom from heating, smooth running at the commutator, and high commercial efficiency, that they are constructing a series to correspond to the outputs for the larger sizes given in the catalogue. For constant-current and for high-tension machines they have adopted the double circuit field-magnet and the sectional ring armature (Joel's patent). A great many machines of this pattern have been built during the past four years, and the type is admirably adapted for high-tension work. The above two types of machine are intended to be stock patterns for the future.

The patent constant-current machines have found a fair number of enquirers and buyers, and a largely increasing business in these is expected. During the past year the firm has constructed a pair of D. R size ($37\frac{1}{2}$ units each), and believe that the great utility of constant-current machines is gradually becoming more recognised.

The combined engine and dynamo, consisting of an improved high-speed open type engine, belted to one of the standard type dynamos by leather link belt, and tightened in by a setting-in pulley, and the whole mounted on a box bedplate of cast iron, has been successfully introduced, and many have been sold and are in successful operation. A great proportion of the energies of the firm have been devoted to the perfection of machinery for the transmission of power, and for telpherage and light railways. They have constructed 11 electric locomotives for telpher electric railways, some of these having a tractive force of 1,500lb. on the drawbar.

In alternating machinery they have made improvements. The transformers used for the lighting of Chelmsford by Messrs. Crompton and Co., Limited, are Statter's patent, and were made by this firm. Messrs. Crompton have been supplied with some additional ones for their installation at the Barry Docks.

The manufacture of alternators for central station lighting has been taken in hand, and several are being constructed for central stations.

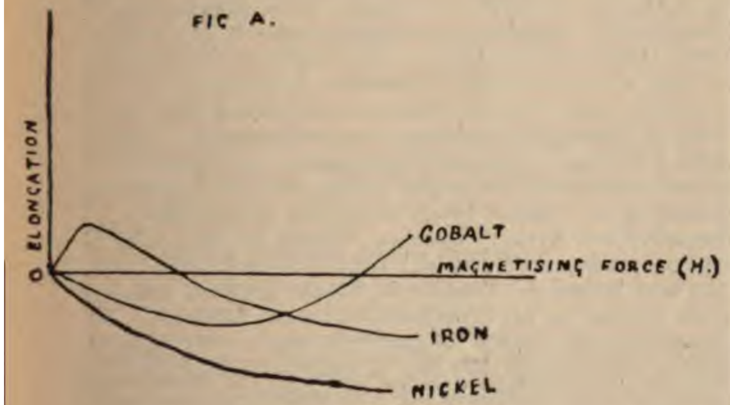
INSTITUTION OF ELECTRICAL ENGINEERS.

The following is an authorised abstract of the continuation of the discussion on the president's address on "Magnetism."

Mr. **Shelford Bidwell**, in reopening the discussion, said the address was above criticism and required no comment, but, as he was greatly interested in the subject himself, he wished to refer to the portion of the paper (slip seven) relating to the influence of stress on magnetisation. If a long, thin iron wire be suspended vertically and subjected to horizontal magnetising forces, its curve of magnetisation, resembling Fig. 1, is easily obtained. If now the wire be stretched by a weight, the curve of magnetisation rises more rapidly at first, but subsequently bends over and cuts the ordinary curve and remains below it as the magnetising force increases. The point of intersection is known as the "Villari critical point," and the change in the relative permeability is called the "Villari reversal." Converse effects were obtained by Joule in 1840, who showed that a bar is lengthened by magnetisation until the magnetising force reaches about 120 C.G.S. units, when no further elongation was observed. Joule's experiment has often been repeated, but until comparatively recently no one seems to have used much greater magnetising forces than those originally employed; the speaker, however, has subjected wires to forces of 800 or 1,000 C.G.S. units, the results of which are shown in the diagram, Fig. A. From this it will be seen that for forces above 100 the elongation diminishes as H increases, and eventually magnetisation shortens the bar. Similar curves for nickel and cobalt are given on the same diagram. In his "Applications of Dynamics to Physics and Chemistry," Prof. J. J. Thomson has shown the elongation and retraction of iron to be closely connected with the Villari reversal, and applying a similar argument to the properties of cobalt, Mr. Bidwell predicted that this metal would present a Villari reversal of an opposite character to that observed in iron, but on trying the experiment the reversal was not found. Probably, however, he had misunderstood Prof. Thomson's argument, for quite recently the latter had predicted a Villari reversal when cobalt was compressed, and this was verified by experiment.

Prof. **Roberts-Austen** stated that there were, from the point of view of a metallurgist, several points in the admirable address to which he wished to direct attention.

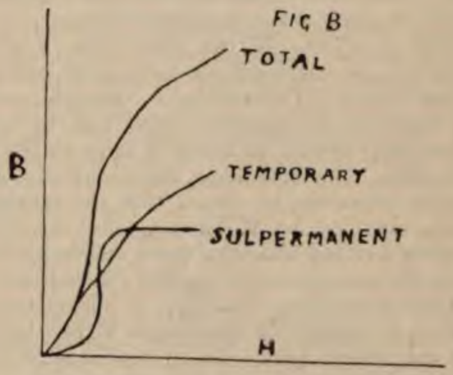
FIG A.



The president had said that wrought iron on cooling does not evolve heat as carbonised irons do. Prof. Austen, however, reminded the society that electro-deposited iron (which is pure iron) does on cooling down from 1,200deg.C. evolve heat suddenly when the temperature falls to 858deg.C. This points to a distinct molecular change in the iron itself wholly unconnected with the presence of carbon. The president, he said, only appeared to recognise a single critical point at which heat is evolved, and to that he always applied the name of "recalescence." Osmond has, however, shown that there are at least two perfectly distinct phenomena which may be observed in cooling masses of iron. First, there was the transformation of hard β iron into soft, or α iron, and, secondly, the "recalescence" of Barrett. Heat is evolved at both points, but the first is variable in position according to the chemical composition of the mass, and is that at which the magnetism reappears. The second point, the true recalescence, occurs at a fairly constant temperature of about 640deg. C., and it has, Prof. Austen considered, no appreciable effect on the magnetic properties of the mass, but is essentially due to a change in the relations between the carbon and the iron. Referring to Dr. Hopkinson's remarks on the "double recalescence of soft steel" he said that the two distinct evolutions of heat were due to totally different causes, and not to any want of uniformity in the mass. As regards the president's statement that the magnetic properties of iron "appertain to the molecule, and not to the atoms of the mass," Prof. Austen asked, Is it a great step from this to admit that more than one kind of iron can exist? Normal iron may, he urged, under certain conditions pass into an allotropic form in which the arrangement of the atoms in the molecule is different from that of ordinary iron, and the physical properties of these two kinds of iron are as totally distinct as those of the allotropic modifications of sulphur and phosphorus are from those of the elements in their normal forms.

Prof. S. P. **Thompson** said the behaviour of the nickel-iron alloy reminded him of a specimen of natural alloy of the same two metals shown to him some years ago by M. Becquerel. This differed in its magnetic properties from Dr. Hopkinson's samples, for although it was non-magnetic when first obtained, it became magnetic on being heated and allowed to cool. Alluding to the supposed instability of iron as mentioned by Prof. Ewing, Dr. Thompson said that in a paper on the mechanism of magnetisation Chwolson* had arrived at some very interesting results. The experimenter endeavoured to distinguish between temporary and subpermanent magnetism, and his curves show that the former increases regularly at first and afterwards more slowly, whilst the latter makes a sudden rise when the magnetising force reaches a certain value and afterwards remains nearly constant as the force increases. The sum of the two effects gives the usual magnetisation cure (*see* Fig. B). Referring to the question of "permeability," Dr. Thompson described a simple apparatus for measuring that quantity which he had recently devised for workshop purposes. This consists of a slab of good iron having a rectangular hole through it. One end of the hole is truly surfaced, and at the other end a hole is drilled in the slab parallel to the length of the rectangle; through this hole the rod to be tested is inserted, and its faced ends rests on the plane surface at the bottom of the rectangular hole. A current is then sent through a solenoid, surrounding the test rod, and the force required to detach the rod from the surfaced end is measured by a spring balance. The permeability is then calculated from the formula $\mu = \frac{1317}{H}\sqrt{\frac{P}{A}}$, where H is the magnetising force used, P the force of detachment in lbs., and A the area of the rod end in square inches.

FIG B



Prof. **Ayrton** asked Dr. Thompson whether the character of the surfaces in his contact affected the results obtained by his new apparatus. He also said the curves for temporary and subpermanent magnetism referred to by the same speaker were very interesting, and had a practical significance in the construction of electrical measuring instruments in which soft iron is used. Speaking of the magnetic properties of iron at high temperatures, he enquired whether the president had tried if these properties were regained at a white heat, for he remembered reading in a pamphlet by Dr. Wormwell that such was the case. On roughly trying the experiment by heating a piece of iron in a blowpipe flame and bringing a magnet near it, he had only found one out of three pieces to give any signs of magnetisation, and of this he was not quite certain. Another question on which he desired information was an apparent anomaly in the magnetisation of two iron rings, which he had constructed some years ago from the same bar and annealed together. One ring is continuous whilst the other is divided at one point by a narrow slit. On determining their magnetisation curves, the induction in the divided ring is found to be considerably below that in the whole one for low values of the magnetising force, but for large forces the induction in the cut ring is decidedly greater than in the uncut one. Another curious effect with the same rings, and which has hitherto remained unexplained, is that the deflection of the ballistic galvanometer caused by changing the magnetising current from + A (amperes) to − A is different from that produced by changing it from − A to + A, and this difference remains however many times the reversals are made.

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* Pogg. Ann. (Ergänzunband), vii., p. 535.

Mr. SWINBURNE, alluding to Weber's Theory of Magnetisation, enquired if any experiments had been made with the object of setting the axes of all the magnetic molecules parallel, and thus reducing the angle of the cone within which, for a given magnetising force, they must all be. As a method of doing this, he suggested that a wire be subjected to longitudinal and circular magnetisation simultaneously. Referring to the terminology of the subject, he said the word "magnetisation" generally conveyed very vague ideas to the average mind, and thought its use should be avoided.

Mr. PREECE described the methods of testing magnet steel used by the Post Office authorities, and promised to add a table of tests to his remarks, as printed in the *Journal*. The tests are made by two methods—1st, by determining the force required to detach an armature; and 2nd, by the magnetometer method. A great improvement, he said, was made in the magnetic quality of steel by the addition of about 3 per cent. of tungsten, the influence of which was brought into prominent notice by the Alvarre steel exhibited at the Paris Exhibition in 1881. Speaking from the records of the Post Office tests, he was sorry to say that the quality of magnet steel is seriously deteriorating, for in 1883 steel giving a permanent induction of over 5,000 C.G.S. units was obtainable, whereas, in 1886, this had fallen to 3,700. Recent tests show a still further deterioration, for one specimen gave 2,320, another 1,948, and a third 1,411. The subject, he thought, required the careful attention of manufacturers, and he hoped that immediate steps would be taken to improve the quality of magnet steel. On examining the numbers obtained by continental observers, he found that the maximum value had been obtained by Kohlraush, and was 3,900. Mr. Preece also directed attention to an article by Prof. Trowbridge, in the current number of the *Philosophical Magazine*, which gives particulars of an alloy of nickel and tungsten. This alloy is capable of retaining a higher degree of permanent magnetism than ordinary tool steel, for the maximum induction amounts to 1,033, whereas that for nickel alone is only 120.

Mr. EVERSHED confirmed Mr. Preece's remarks on the deteriorating quality of magnetic steel, and said that in testing magnets he found it very convenient to use a test coil and galvanometer. Referring to nomenclature, Mr. Evershed said he was one of those who thought there was no need to use the word magnetisation in its present ambiguous sense, and that the ideas of polarity, magnetic moment, free magnetism, etc., were not required, except, perhaps, for permanent magnets; even with them, now that the president had given a definite meaning to "coercive force," this value of H together with the permeability seemed to him to give all the necessary information. He also thought the word "induction" should be defined to mean what is generally called "total induction," and a new name should be given to density of induction, or induction per unit area. For some time past he and his colleague Mr. Vignoles have been in the habit of using the word "Thomson" to denote a line of force, but they would be quite willing to adopt any other name which would meet with general approval. Quite recently he had been engaged with Mr. Vignoles in investigating the properties of iron when subjected to magnetic cycles such as occur in transformers, and had found it a great convenience to wind the transformer with two primaries. In one of these a constant current is maintained, and the whole cycle is obtained without reversing the testing current in the other coil. Speaking of the instability referred to by Prof. Ewing, Mr. Evershed said their results gave no indication whatever of such a phenomenon, and as to the effect of vibration, they had found that a good blow with a hammer only produced a change of about 2 per cent. at the most sensitive part of the curve. Prof. Ewing's results, he ventured to think, might be due to want of endlessness in the specimens tested.

Some discussion took place between Profs. AYRTON, THOMPSON, and PERRY, and Messrs. EVERSHED and VIGNOLES, as to whether there was any advantage in having two primaries on the transformer used in the experiments on magnetic cycles, but no very clear understanding was arrived at, excepting that the latter gentleman considered it much more convenient to change the magnitude of a current than to reverse it.

Mr. A. P. TROTTER asked the president whether the sample of nickle-iron alloy whose properties were represented in Fig. 11. was unique, or whether other alloys have been found to give similar results. The remarkable peculiarities of this specimen suggest the possibility of copper, lead, etc., being cooled low enough to become more magnetic than Mr. Prece's magnetic steel.

The PRESIDENT, in replying to Sir W. Thomson's remarks on recalescence, said that on heating the metal a considerable absorption of heat occurs at about 30deg. C. above the temperature at which recalescence takes place on cooling, but his experiments proved that the changes in the magnetic properties follow precisely the absorption and liberation of heat, both in ascending and descending. Referring to Prof. Ewing's remarks on what he called the "hysteresis of nickel steel" shown in Fig. 11, Dr. Hopkinson said he thought the word hysteresis not very appropriate when applied to this phenomenon, for he considered the peculiarity more analogous to change of state from liquid to gas, or *vice versa*, as in the case of water, for example, these changes can be considerably retarded by adopting suitable precautions. Prof. Roberts-Austen had, he said, alluded to the liberation of heat when iron changed from the non-magnetic to the magnetic state. The phenomena accompanying this change seemed to him (the president) to be analogous to "boiling with bubbling," where the temperature of the liquid is first raised considerably above the boiling point and a sudden liberation of vapour brings down the temperature. As regards Prof. Ayrton's question relating to the return of the magnetic property at high temperatures, he could only say that he had not observed it, but the greatest temperature attained in his experiment was about 950deg. C. To experiment at higher temperature was a very difficult matter, for copper is then near its fusing point, and platinum cannot be used because at this temperature it decomposes the silica of the asbestos used to insulate the magnetising and test coils. He could not offer any explanation of the observations on the iron rings described by Prof. Ayrton, and for the present must regard them as anomalous. Referring to the revision of terminology suggested by several speakers, Dr. Hopkinson thought there was no necessity for this, for the terms "pole," "magnetic moment," etc., were most convenient when talking of permanent magnets, whilst "induction" and "permeability" were preferable when the magnetisation of iron was under discussion. In reply to Mr. Trotter, he said that many other alloys had been tried, and one specimen of nickel-steel, containing 5 per cent. of nickel, gave very similar results to that shown in Fig. 11, but the range between the critical temperatures was considerably shorter, these temperatures being 650deg. C. and 800deg. C., respectively. The same sample tested for recalescence was found to heat about 800deg. C., and, on cooling, heat was liberated about 650deg., thus showing the close connection between these phenomena and magnetisability. Since last meeting, he had tested the variation of specific resistance of nickel-steel with temperature, and found that a considerable reduction was produced by cooling it in solid carbonic acid. On heating, its resistance increased slowly and uniformly at first, and afterwards with increasing velocity until a temperature of 600deg. was reached. At this temperature a sudden change occurred, and the resistance increased more slowly and uniformly as the temperature rose. On cooling the specimen, its resistance fell uniformly, until, at the ordinary temperature, it returned to its initial value. The whole cycle could be repeated by again cooling in carbonic acid and proceeding as before. Fig. C shows diagrammatically the character of the change. Other samples were tested for tensile strength, and when in the ordinary state gave an average breaking stress of 50 tons per square inch with an extension of 30 per cent.; specimens which had been chilled broke at 85 tons with an extension of only 8 per cent. This fact, he said, was of vast importance from an engineering point of view, for if such changes in the nature of a mild steel were brought about by its being subjected to a hard frost, the consequences would be very serious if such a metal were used in structures.

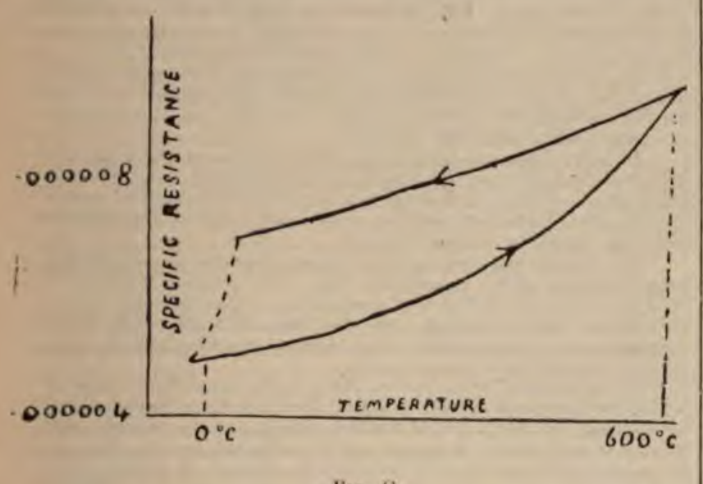

FIG. C.

BRIGHTON.

REPORT OF THE LIGHTING COMMITTEE.

The following is the report of the Lighting Committee as to the overhead mains of the Brighton Electric Lighting Company, and as to exercising the powers conferred on the Corporation by the Brighton Electric Lighting Order, 1883.

The Lighting Committee report as follows:

I.—AS TO THE OVERHEAD MAINS OF THE BRIGHTON ELECTRIC LIGHTING COMPANY.

In pursuance of the resolution of the committee of the 9th December last, the Mayor and chairman of the committee (Councillor Ewart), accompanied by the borough members, the Right Hon. Sir W. T. Marriott and Mr. Gerald W. E. Loder, the Town Clerk, and Mr. J. N. Shoolbred, C.E., had an interview with Mr. Courtenay Boyle and Major Cardew, representing the Board of Trade, at the offices of the Board, on the 16th December, and urged upon them the advisableness of permitting the present arrangements of the company for the supply of electricity in Brighton to remain undisturbed until such time as the Corporation have laid mains for, and are ready to give a supply under the powers of their order, and that at the request of the Board the representations of the deputation were subsequently embodied in a letter addressed to the Board by the town clerk.

The committee now submit for the information of the Council the reply of the Board to their application.

The following is a copy of the Board's communication:

(COPY.)

"Board of Trade (Railway Department), London, S.W.,
"January 13th, 1890.

"*Electric Lighting Act*, 1888.

"Sir,—With reference to your letter of the 2nd inst., requesting, on behalf of the Town Council of Brighton, that the notice which the Board of Trade proposed to give to the Brighton and Hove Electric Light Company, Limited, to the effect that this department would be compelled to take steps to enforce the provisions of section 4 of the above-mentioned Act, if the reconstruction of the company s lines in accordance with the requirements of this department should not be completed within a period of three months, should be held over for the present, I am directed by the Board of Trade to point out that the probable effect of acceding to the request of the Town Council would be that the existing dangerous condition of the supply, which has been pointed out by the inspectors of this department, would be continued for a longer period than was contemplated by the Board of Trade to be necessary to enable the company to reconstruct their system.

"As, however, the Town Council, who are acquainted with all the circumstances of the case, are desirous that no further action should be taken by this department, the Board of Trade will defer to their wishes; but they must at the same time point out that the Town Council will incur a grave responsibility by allowing the present dangerous condition of the works to continue longer than is absolutely necessary.—I am, sir, your obedient servant,

(Signed) "HENRY G. CALCRAFT.

"The Town Clerk, Brighton."

2.—AS TO EXERCISING THE POWERS CONFERRED ON THE CORPORATION BY THE BRIGHTON ELECTRIC LIGHTING ORDER, 1883.

The powers of the Corporation to provide a supply of electricity for public and private purposes were conferred in 1883 by an order of the Board of Trade granted upon the application of the Council, pursuant to the provisions of "The Electric Lighting Act, 1882," which order was confirmed by Parliament in the session of the same year (1883).

The order is entitled "The Brighton Electric Lighting Order, 1883," and it enacts that the area of supply (usually called the compulsory area) shall be the part of the borough bounded on the north by North-street, on the east by East-street, on the south by the Junction-road and King's-road, and on the west by West-street, and that any other part or parts of the borough may be added to the area of supply from time to time by special resolution passed at a meeting of the Council after due notice, and confirmed at a further meeting of the Council held at an interval of not less than one month after the first meeting.

The General Purposes Committee in their report dated 23rd January, 1889, recommending the Council to refuse their consent to "The Brighton and Hove Electric Light Supply Order, 1889," applied for by the Brighton Electric Lighting Company, Limited, stated that

"The powers of the (Corporation) order have not hitherto been exercised, in consequence of the uncertainty surrounding the question and the fear that works established with a view to adopting any particular system of supply would within a short period become useless by the invention of more suitable machinery and appliances, or the discovery of more economical means of supplying electricity. Great progress has been made in these directions since the date of the Corporation order (1883) and the committee are of opinion that the Council may shortly be able to commence the supply of electricity under their powers, without incurring serious risk of loss. They learn that the Corporation of Bradford (who also obtained a provisional order in 1883) have recently laid down mains, and are about to commence to supply a small area in their borough at an estimated capital outlay of £20,000."

It will be remembered that in May, 1889, the Board of Trade refused the application of the company above referred to, in consequence of the undertaking given to the Board on behalf of the Corporation that they would themselves, within two years provide a supply of electricity to the inhabitants of the borough, and that the Council, with the purpose of redeeming that promise, subsequently authorised this committee to consult Mr. Shoolbred, C.E., the electrical engineer of the Bradford Corporation, with a view to his advising the Council as to the most advisable course to pursue.

In pursuance of that authority the committee have had several conferences with Mr. Shoolbred, and he has presented to them the following report:

(COPY.)

"BOROUGH OF BRIGHTON.—ELECTRICITY SUPPLY.

"The Town Cleak, Brighton: Sir,—In accordance with your instructions, 'to advise the Corporation as to the best course to pursue in order to provide a supply of electricity for the borough,' and in conformity with the conditions of 'The Brighton Electric Lighting Order, 1883,' I beg to submit the following remarks:

"It may be mentioned introductorily that in 1883 only a few towns, of which Brighton was one, considered it advisable, and even necessary in the interest of their ratepayers, that the local authority should itself become the sole authority for the supply of electricity over its municipal area.

"Now, however, almost all the large towns of Great Britain have decided, almost unanimously, that such authority should be retained by the municipal body itself, and not be allowed to pass even temporarily into the hands of a company.

"The Corporations of Manchester, Nottingham, Oldham, Bedford, Leicester, Birkenhead, Blackburn, Harrogate, Wolverhampton, York, and many others are applying this year to Parliament for powers to become the authority for the supply of electricity in their respective towns. In fact, the number of large towns who are not so doing is very small.

"The chief reason for this very marked alteration in the opinion of local authorities seems to be, that they consider it would be highly prejudicial to the interests of their own ratepayers to allow a body of individuals, trading for their own profit, and in many cases foreign to the town, to become for a period of years the masters of the local authority, and who would eventually have to purchase back from the traders their own rights over the town at a considerable cost to the ratepayers.

"When a local authority, as in the case with Brighton, decides to carry out the provisions of its own order, there remain two courses open to it. 1st. To carry out and keep under its own control the works necessary for the supply of electricity, in the same way that Corporation gas works, or water works, are carried on; or, 2nd. To contract with some private individuals, or firm, to supply for a certain time electricity to the town at their own cost and risk, but subject to the conditions imposed upon them by the local authority. Or, in other words, to farm out the supply for the term indicated.

"There would still, despite conditions to the contrary, remain in the latter case to the local authority a certain amount of risk and of responsibility in the event of the inability of the contractors to carry out effectively the supply, and likewise as to the condition and fitness of the installation for continuance of work at the termination of the contract. Both of these matters would mean outlay to the ratepayers.

"There still exists in some quarters an impression that a local authority, by adopting the first-named course (that of carrying out its own supply) are risking their ratepayers' money in a concern of a tentative character, and where loss might ensue for a time at first.

"The only actual answer (so far) to this lies in the result of the works laid down by the Corporation of Bradford—the only corporation, up to the present, who are themselves carrying on the distribution of their own supply of electricity. The installation (after being well constructed and handed over in a good working condition by thoroughly reliable contractors) is being worked regularly, and without difficulty, by the Corporation. Indeed, with much more ease and with a smaller staff than would be the case with gas works capable of producing the same amount of light. The demands for a supply of electricity there are already greater than the present plant can supply, and those demands are constantly increasing; while so satisfied are the Corporation themselves with the investment of the first instalment of capital, that they have decided to more than double it, so little risk do they consider is attached to the undertaking.

"MODE OF SUPPLY BEST SUITED TO BRIGHTON.

"There are two methods, or 'systems,' as they are termed, in use with central stations for the generation and the subsequent distribution of the electrical energy. These are known as 'the continuous-current' system, and 'the alternating-current' system.

"It may here be mentioned that the words 'current' and the 'flow' thereof, still popularly used in speaking of electrical matters, are not intended to mean any actual translation of matter.

"Those words imply, more precisely, that the molecules forming the conducting wires are thrown, by the exciting magnetism of the dynamo, into a temporary and unstable condition of disturbance, and that this artificial condition is communicated from one molecule to its neighbour, and so throughout the length of the conductor.

"When this motion is continuous in one direction (due to the construction of the dynamo) the result is popularly termed 'a continuous current.' When, however (owing again to the construction of a second dynamo), the motion lengthwise along the conductor is first in one direction and then in the opposite one, the result is then termed 'an alternating current.'

"The reversals in the latter case usually occur as often as 60, 80, or even 100 times per second. It will be readily understood that a shock to the human system from the latter kind of current produces a wrench which is far more serious than the shock from a continuous current.

"The scope which exists for the applications of these two kinds of current differs considerably.

"With the 'continuous' there is apparently no limit; all the ordinary applications, such as lighting, transmission of power, storage, deposition of metals, and many others for domestic and general use, being included. While with the 'alternating' the only application to which it has, so far, been found suitable is lighting.

"By both systems the current can be supplied at either low pressure (that is, at the pressure required by the Board of Trade for use within houses and other premises), or at something above this, which is termed high pressure; and which, of course, may vary very much, until it becomes so great as to become fatal to human life.

"The reason for the use of high-pressure currents lies, generally, in the fact that a considerable amount of energy can in that mode be conveyed along a copper conductor of but small section, and with a corresponding economy in the cost thereof.

"But the high-pressure current, before being used in houses and other premises, must be reduced to low pressure. This reduction is effected by means of instruments which are called 'transformers' or 'converters,' or again this can be effected with continuous currents, by means of storage batteries.

"The cost of the two first-named reducing instruments is found, however, to be so considerable (unless the distances be very great) as to neutralise the economy effected in the conductors.

"With regard to storage batteries, they may be looked upon as much more than mere reducing instruments—as they introduce at the same time the very valuable adjunct of accumulation of energy.

"Apart from the safeguard which these accumulators afford as against accidents to the electric machinery, they play a most important and economical part in the relief which they give to the engines and dynamos by allowing them to be stopped during the night and at other times when the demand for the supply is but slight. The resulting oconomy not merely in coal and water, but more especially in wages and in diminution in the number of the staff, is very marked; more particularly as eight hour shifts are now almost generally admitted as the sequel to the recent strikes.

"Inasmuch, as with the alternating-current system no use can be made of storage batteries, it follows that the engines and other machinery must necessarily be kept going without interruption during the entire time that the supply is needed. To do this with only a moderate amount of supply going on (as is generally found to be the case during at least sixteen out of the twenty-four hours), necessarily throws upon this mode of generation of energy a very heavy financial burden, which the continuous-current system escapes from. Not to speak of the additional machinery which must always, with the alternating system, be kept ready to guard against accidents, or to ensure time for any necessary repairs.

"In selecting the mode of supplying any article which may have a considerable public demand, three things—viz., safety, simplicity, and general usefulness—are matters which would have much weight in making the selection.

"With a public body, like a local authority, these points should have considerable weight in deciding on the system upon which an electric supply should be distributed to the area within their jurisdiction.

"In a town like Brighton, where the distances, though in some cases considerable, are not great, the 'continuous-current' system at low pressure, supplemented by accumulators, would, in my opinion, be best suited to the requirements of the inhabitants.

"Of the several sites available for the generating stations which *have been pointed* out to me, and which are the property of the Corporation, the one at the Park-street Depot seems suitable; more so than that at the water works on the Lewes-road, where, although more land is available, its position being so far away from the principal part of the town would at present, at least, diminish its usefulness. A third station in the neighbourhood of the Queen's-road would be most useful for the supply of the western portion of the town. These stations could, if desired, be made to assist one another. It would hardly be necessary, or even advisable, to undertake all these stations at once. Probably one only would be required at first.

"On approaching the matter of the works which are necessary for the supply of electricity, there arises at once the question as to the portions of the town to which it should be supplied, and the extent of the supply which should be provided.

"It will be remembered that the part of the town which (in the Board of Trade Electric Lighting Order) is undertaken to be first supplied with electricity, is that which is comprised between West-street, North-street, East-street, and the King's road; and to this district must the supply be necessarily given.

"But it is evident that the town is now ripe for a more extended supply outside of the compulsory area. The portion of the town west of that area as well as that eastward up to the east side of the Old Steine, and extending from the line of Church-street, Upper North-street, and Montpelier-terrace, down to the King's-road, might well be included in the area of supply.

"The entire distributing system (that is, the network of mains to which the houses are directly attached) should be upon 'low pressure,' as required by the Board of Trade in the houses themselves. Not merely in the interests of general safety should this be done, but also to inspire public confidence in freedom from danger. It should not be forgotten that increased confidence in the supply means an additional number of customers.

"In adopting such a system of distribution it is essential, in order to preserve an uniform rate of pressure over the town, that districts of comparatively small area should be formed, from which the electric current would be supplied direct to the consumers.

"Owing to the extreme value of land in the middle of a large town, it is of the utmost importance that the generating plant, as well as all the other arrangements at each station, should be of the most compact form, so as to occupy the least amount of ground compatible with due efficiency.

"Inverted-vertical engines, triple expansion, working at about 200lb. boiler pressure, and driving each its dynamo direct, would best comply with the above conditions.

"In order to secure that these engines and dynamos should work under favourable and economical conditions, it might be desirable to make some difference in the size and output of these engines in order to meet the varying demands of the supply.

"Similarly, in order to ensure due efficiency in the boilers, both as regards general economy in steam production and as to rapidity in so doing (when required), it is probable that more than one type of boiler would have to be erected. The Cornish, or the Lancashire boiler, possesses certain advantages in certain conditions over the tubulous boiler, and *vice versa*. Mild steel should be employed in the construction of these boilers where possible.

"The design and construction of the requisite buildings at the station should be such as not merely to be adapted to the site itself, but also to be suited without much alteration to a more extended supply. The more especially, as the conditions of a proper supply to the town would not admit of any interruption taking place in that supply, in order to allow of reconstruction.

"In accordance with the preceding remarks an installation that would allow of 10,000 16-c.p. lamps being connected to it, with a maximum of 50 per cent. in use at one time, could be laid down for the supply of electricity to the houses and other premises not merely in the compulsory district first-named, but also for that of the more extended area, as already described.

"The cost of such a supply in working order would be about £30,000, to be distributed in the following manner:

"Buildings	£3,000
"Boilers	2,800
"Engines	2,400
"Dynamos	2,800
"Instruments	800
"Mains and distributing service	9,600
"Storage batteries	5,500
	26,900
"Meters, house services and contingencies	3,100
	£30,000

"This supply would be available throughout the entire 24 hours, since storage batteries are included in order to carry on the supply during the late hours of the night and of the early morning, when the demand has become so small as to make it desirable to stop the engines, and thus diminish the hours of working at the station.

"Respecting the price to be charged, the provisional order allows 7d. per unit, but the writer does not think that a higher rate than 6d. per unit would be advisable, and in this he quite agrees with some recent remarks of Alderman W. H. Hallett, J.P., on the subject.

"It may not be out of place here to say a word as the term 'unit.'

"The 'unit' is a measure of energy introduced by the Board of Trade, about six years ago, to represent 1,000 volt-ampere (or watt) hours, and it is more generally known in international scientific language as a 'kilowatt.' The 'unit' may be taken as the equivalent of 1½ h.p. hours, indicated by the steam-engine. In order to arrive at some comparison between the illuminating value of a 'unit' and 1,000 cubic feet of gas, it is found convenient to take the latter of 15 candle illuminating power, comparing a No. 5 gas-burner with a

16-c.p. incandescent lamp. The result being that the consumption of an 'unit' of electricity produces as much light as the consumption of 100 cubic feet of the above gas. At the above-named charge of 6d. the 'unit' would be paid for at the rate of 5s. per 1,000 cubic feet of 15-c.p. gas. A charge of 6d. per unit for the electric supply would certainly be a low one considering the distance that Brighton is from the coal districts, and it is a charge which ought to attract many consumers. Yours faithfully,

(Signed) "James N. Shoolbred, M.I.C.E.

"Westminster, December 31, 1889."

The committee having given Mr. Shoolbred's report a full and careful consideration are of opinion that it is advisable the Council should themselves carry out the provisions of the Corporation Electric Lighting Order; and the committee submit the following recommendations for the approval and confirmation of the Council:

1. That electric lighting works be established with the necessary plant, machinery, and appliances, and that proper mains be laid under the public streets, for the supply of electricity by the Corporation, for public and private purposes within the borough, under the powers of "The Brighton Electric Lighting Order, 1883."

2. That the system of supply to be adopted should be the continuous-current system at low pressure, combined with storage batteries.

3. That the area of supply defined in Schedule A to the Brighton Electric Lighting Order, 1883, be extended by adding thereto so much of the borough, outside of and surrounding the area of supply so defined, as is coloured light pink on the plan submitted, and lies between the eastern side of the Old Steine on the east, the western boundary of the borough on the west, the southern boundary of the borough on the south, and Montpelier-place, Montpelier-terrace, Upper North-street, and Church-street on the north, the houses on both sides of such streets being included within the area.

4. That works for the supply of electricity within the extended area of supply as above defined, and in accordance with the foregoing resolutions, be forthwith established at an estimated cost of £30,000, and that the town clerk do apply to the Local Government Board for sanction to borrow the said sum of £30,000 on security of the general district rates, the same to be repaid within a period of 40 years.

5. That the committee recommend that the price to be charged for any electricity which may be supplied by the Corporation shall be at the rate of 6d. per unit.

6. That the committee be authorised to select a suitable site or sites for the works, to provide all necessary machinery, plant, and appliances, and to prepare and submit for the approval of the Council such contracts as they think advisable for the supply, erection, and construction thereof, and for laying mains under the public streets.

The committee also report that, having agreed on the above recommendations, they requested the Mayor, their chairman (Councillor Ewart) and Alderman Hallett to confer with Mr. Shoolbred as to the terms upon which his professional services may be continued to the Corporation, and these gentlemen have presented the following report:

(Copy.)

"*To the Lighting Committee of the Town Council of Brighton:*

"Gentlemen,—In accordance with your resolution of the 13th inst., we have conferred with Mr. James N. Shoolbred, C.E., as to the terms and conditions upon which his professional services may be retained for the Corporation, and we find that Mr. Shoolbred is willing to undertake to design, superintend, control, and be responsible for the whole of the work of the installation, and for three calendar months after the delivery of his final report that the works are completed, for that part of the borough shown by a pink tint on the plan (if he is allowed the assistance of a clerk of the works, to be appointed by him and paid by the Corporation) upon the terms of his being paid a commission of five per cent. on the purchase of machinery, plant, and appliances, and upon work executed by tradesmen and contractors in connection therewith, but not including work done by or through the Corporation, or on the purchase of sites or of buildings for the purposes of the electric supply, the commission to be inclusive of travelling expenses.

"We recommend that Mr. James N. Shoolbred, C.E., be appointed electrical engineer to the Corporation on the terms above mentioned.

"We also recommend that Mr. Shoolbred be authorised to select such a suitable and competent man as clerk of the works (at a salary of £3 per week) who might afterwards be fit, if approved of by the Council, to take charge as local electrical engineer.—We are, gentlemen, yours faithfully,

(Signed) "Geo. Manwaring, mayor.
"Joseph Ewart, chairman.
"W. H. Hallett."

690005

In conclusion, the committee recommend that the arrangement made with Mr. Shoolbred be confirmed.—On behalf of the committee,

(Signed) Joseph Ewart, chairman.

Town Hall, Brighton, January 17, 1890.

PHYSICAL SOCIETY.—Jan. 17.

Prof. W. G. Adams, Vice-President, in the chair.

Owing to the unavoidable absence of Mr. F. B. Hawes, his paper on "A Carbon Deposit in a Blake Telephone Transmitter" was postponed.

Dr. S. P. Thompson made a communication **"On Electric Splashes,"** and illustrated his subject by beautiful experiments on the production of Lichtenberg's figures. The author has recently investigated these phenomena as modified by varying the conditions under which the figures are obtained, and has arrived at the following conclusions: First, the nature of the dielectric plate does not change the character of the figures produced, and, secondly, the nature of the powders used seems to have no material effect on their shape. In the course of his experiments he has found a mixture of sublimed sulphur and lycopodium to give better figures than the red lead and sulphur usually employed, and also that a large and highly-polished knob is advantageous, particularly when the Leyden jar is charged negatively. Sometimes when obtaining negative figures nebulous patches occur, and these were attributed to the so-called electric winds sent off from roughness on the knob when not sufficiently well polished. If, instead of bringing the knob in contact with the plate, it is only brought near to it, then a peculiar figure, closely resembling a "splash," results. A positive splash consists of short lines radiating from the point of approach, whilst a negative splash is made up of more or less rounded spots, which become elongated in a radial direction as their distance from the centre of the splash increases. Negative splashes are, however, much more difficult to produce than positive ones. When viewed in the dark, the discharge producing the splash is seen to consist of a bundle of small sparks, which branch outwards on approaching the plate. In conclusion, the author remarked that roughnesses on a conductor produce more electric winds when the conductor is charged negatively than when positively charged, and invited the opinions of members as to the causes of the differences observed between positive and negative electricity. **Prof. Rucker** said he had recently obtained figures produced by discharges on photographic plates. Generally, he observed that negative discharges produce roundish patches, whilst positive ones give more filamentary figures. On passing a spark across a glass plate covered with lampblack, its trace was found to have a black core at one end whilst the other was quite clear. He also made remarks on the distinctive character of the positive and negative discharges in partial veins, and considered investigations as to the causes of such differences to be of great importance. **Prof. Adams** thought any attempt to discover the causes of such differences as those noted in the paper was to be commended, for the well-known fact that it is more difficult to insulate a negative charge than a positive one has long needed an explanation.

A paper **"On Galvanometers,"** by Prof. W. E. Ayrton, F.R.S., T. Mather, and W. E. Sumpner, D.Sc., was read by **Prof. Ayrton.** In fitting up the physical laboratories of the Central Institution of the City and Guilds of London Institute, the authors have had occasion to obtain galvanometers of various types and patterns, some of which have been made to special designs, and specimens of instruments embodying recent improvements were exhibited at the meeting. The question as to whether fairly-sensitive galvanometers should be astatic or non-astatic was answered in favour of the former system, from the fact of its being less affected by external magnetic disturbances, and the greater ease with which great sensibility may by obtained. The usual method of placing the mirror inside the coil was shown to be undesirable, and in the newer forms of instruments Mudford's improvement of placing the mirror outside the coils has been adopted, the space near the axis of the coil being nearly filled with wire. It was also shown that if wire be wound in a certain approximately spheroidal space near the magnets, then these convolutions will tend to oppose the more distant portions of the coil; however, by winding the two parts in opposite directions they conspire to deflect the magnet. Details as to methods of supporting the coils were then discussed, and the importance of fitting them in boxes mounted on hinges, or otherwise, so as to be readily removable, was pointed out. A galvanometer devised for teaching purposes and provided with variable damping arrangements was discussed, in which the damping is effected by enclosing the mirror in a glass cell, whose sides can be caused to approach or recede by turning a milled head outside the instrument. This arrangement enables the damping to be varied between wide limits, and its effect on the swing produced by a given discharge can be determined. The instrument is also serviceable both as an ordinary damped galvanometer or as a fairly ballistic one. In measuring quantities of electricity by the first swing of a galvanometer needle, a correction has usually to be introduced for damping; this correcting factor is simple enough when the damping is small, but becomes more complicate as the damping increases, and to facilitate the calculations a table of values of the factor for various values of λ (the logarithmic decrement) has been calculated. From this it appears that for values of λ less than 0·5 the value of the factor is very nearly $1+\frac{1}{2}\lambda$, the correction usually employed. Improvements in methods of insulating the coils and terminals of galvanometers required for insulation tests were next described, the principle of which may be gathered from Figs. 107, 108 in Prof. Ayrton's "Practical Electricity." A special form of instrument for high insulation work was exhibited, in which the copper resistance of the coils is nearly 400,000 ohms, and the shortest path along which surface leakage can take place from the coils to the base of the instrument is between 30in. and 40in. of ebonite artificially dried by sulphuric acid. This is attained by supporting the coils from two corrugated ebonite rods, which depend from a brass ring carried on the top of three corrugated pillars fixed to the base plate. The instrument was constructed to drawing and specification by Messrs. Nalder Bros., but the method of supporting the coils was suggested by Messrs. Eidsforth and Mudford. With reference to the proportionality of deflection to current in reflecting galvanometers, it was pointed out that ordinary instruments may differ as much 2 per cent. within the limits of the scale; hence showing the necessity for calibration when any approach to accuracy is desired. Galvanometers of the D'Arsonval type sometimes differ from proportionality quite as much as the one above referred to, but by fitting such instruments with curved pole-pieces, and allowing the coil

690005

10 JANV. 91
PARIS

to hang freely from the top suspension, a proportionality true to less than 0·15 per cent. has been attained over a scale about 30in. long. Coming to the question of sensitiveness, the importance of keeping the wire as close as possible to the magnets was brought prominently forward, as well as the necessity of reducing the "figures of merit" of various instruments to the same standard in comparing their sensibilities. The standard adopted as most convenient and closely approximating to practical usage is arrived at by supposing the distance of the mirror from the scale to be equal to 2,000 scale divisions, and the sensibilities for current and quantity are given as scale divisions per micro-ampere and scale divisions for micro-coulomb respectively. The period of oscillation is also taken into account. A table showing the resistances, sensibilities, coefficients of self-induction, and volumes of the coils of various instruments, together with the relations existing between them, accompanies the paper, and from this it appears that in the best astatic double coil instruments, of from 10,000 to 30,000 ohms resistance, the number of scale divisions per micro-ampere may reach 400 times the resistance of the $\frac{3}{5}$th power (400 R $\frac{3}{5}$) when the period is 10 seconds. In obtaining data of various instruments the authors have consulted, amongst others, Prof. Threlfall's paper on the "Measurement of High Specific Resistances" in the *Philosophical Magazine* for Dec., 1889, and noticed two serious errors. The first of these makes an instrument constructed according to Messrs. Gray's pattern nine times less sensitive than it actually was, whilst the sensibility of a form recommended in the paper is given as 17 times too great.

On account of the lateness of the hour the discussion was adjourned till February 6th, before which time it is hoped that a fairly full abstract will appear in the technical papers.

NEW COMPANIES REGISTERED.

Norwich Electricity Company, Limited.—Registered by G. B. Kennett, solicitor, Norwich, with a capital of £50,000 in £10 shares. Object: to carry on, at Norwich and elsewhere, the business of an electricity company in all its branches. The first subscribers are:

	Shares.
G. F. Buxton, Thorpe	1
A. R. Chamberlain, The Grove, Norwich	1
J. B. Coaks, Thorpe	1
R. J. Colman, Bacondale Woods, Norwich	1
C. R. Gilman, Stafford House, Norwich	1
F. W. Harmer, Oakland House, Cringleford	1
G. B. Kennett, Norwich	1

There shall not be less than five nor more than 10 Directors. The first are George Fowell Buxton, A. R. Chamberlain, J. B. Coaks, R. J. Colman, F. W. Harmer, C. R. Gilman, and G. B. Kennett. Qualification, £250. Remuneration to be determined in general meeting.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The receipts for the week ended January 24 amounted to £5,354.

Edison and Swan United Electric Light Company, Limited.—A half-yearly interim dividend at the rate of 7 per cent. per annum has been declared by the Board of this Company.

Western and Brazilian Telegraph Company.—The traffic receipts for the week ended January 24, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £4,044.

Woodhouse and Rawson United, Limited.—The Board of Directors of this Company announce that they have decided to pay an interim dividend for the half-year ending December 31, 1889, in respect of profits realised since the formation of the Company, at the rate of 8 per cent. per annum on the preference shares, and of 15 per cent. per annum on the ordinary shares of the Company, payable on the instalments from the date of their payment. The Directors take the opportunity of informing the shareholders of the prosperous condition of the Company, and of the success that has attended it since the amalgamation of the various businesses it was formed to acquire, the transfer of which is in steady progress. They confidently expect that the results of the present year's working will fully confirm the anticipations put forward on the formation of the Company.

Liquidation.—Messrs. Mayfield and Co., Limited, of 35A, Queen Victoria-street, notify us that arrangements have been made to enter into liquidation. As already notified, the connection with Mr. Cobb, of Woolwich, ceased in February last, and, as Mr. Mayfield and Mr. Todman have made an advantageous offer for the purchase of the remaining business from the Company, it has been determined to sell, and they will, as from January 1st, 1890, trade as private individuals. Mr. Mayfield will take over the businesses at 35A and 41, Queen Victoria-street, and Mr. J. T. Todman the factories at Bermondsey-street and Woolwich. Accounts to the end of 1889 will be accepted by the present Company, and will be paid in full in due course. No further business will be done by the Company, and all future purchases should be debited to Mr. Mayfield and Mr. Todman respectively.

Anglo-American Telegraph Company, Limited.—This Company in their report state that the total receipts from July 1 to December 31, including the estimated balance of £2,465 brought forward, are estimated at £157,109. This amount, however, is subject to revision, dependent upon the result of the lawsuit still pending between this Company and the Paris and New York Telegraph Company. The traffic receipts show an increase of £23,839 as compared with the corresponding period of last year, and this increase, it is stated, would have been considerably larger had it not been for the interruptions which occurred during the past year to the cables of the associated companies. The total expenses, including repair of cables, etc., amounted to £58,611. Interim dividends of 12s. 6d. per cent. on the ordinary and 25s. per cent. on the preferred stocks were paid on November 1, leaving an estimated balance of £54,747, out of which the Directors recommend final dividends of 15s. per cent. on the ordinary and £1. 10s. per cent. on the preferred stocks, making a total distribution for the year ended December 31 of £2. 15s., and £5. 10s. per cent. respectively, leaving an estimated balance of £2,247 to be carried forward.

PROVISIONAL PATENTS, 1890.

JANUARY 20.

993. **Improvements in holders for incandescence electric lamps.** John Wigham Edmundson and William Clarke, 46, Lincoln's-inn-fields, London.

1026. **Improvements in or relating to automatic accumulator switches.** Wilfrid Swanwick Boult, 24, King's Mount, Birkenhead.

JANUARY 21.

1028. **A new or improved method of converting a direct or continuous electric current into an alternating current, and improvements in or relating to apparatus therefor.** William Phillips Thompson, 6, Lord-street, Liverpool. (Ludwig Guttman, United States.) (Complete specification.)

1031. **Electric compass and course recorder.** Joseph von Peichl, 28, Southampton-buildings, London.

1037. **Improvements in mechanical telephones.** Robert Caldwell Mackey Bowles, 62, St. Vincent-street, Glasgow. (Complete specification.)

1050. **Improvements in dynamo-electric machines and electric motors.** Carl Bollé, New Bridge-street, Manchester. (Ludwig Gutmann, Pennsylvania.) (Complete specification.)

1072. **Improvements in electrical switches.** Gustav Binswanger, 71, Queen Victoria-street.

1094. **Improvements relating to secondary or storage batteries.** Henry Harris Lake, 45, Southampton-buildings, Middlesex. (Thomas Ewing, United States.) (Complete specification.)

1106 **An improved system of electrical distribution.** Hiram Henry Carpenter, 77, Chancery-lane, London. (Complete specification.)

1110. **An improvement in galvanic batteries.** Charles Addison Hitchcock, 28, Southampton-buildings, London. (William Burnley, United States.) (Complete specification.)

JANUARY 22.

1143. **Improvements in or connected with telegraphic apparatus applicable for use in navigable vessels and analogous purposes.** William Chadburn, 15, Water-street, Liverpool.

JANUARY 23.

1226. **Improvements in incandescent electric lamps.** John Alexander McMullen, 9, Warwick-court, High Holborn.

JANUARY 24.

1280. **Improvements in switches used for electrical purposes.** Charles Laurence Baker, Cadby Hall Works, Hammersmith.

1281. **Improvements in secondary batteries.** Victor Hugo Ernst, 321, High Holborn, London. (Date applied for under Patents Act, 1883, Section 103, 28th September, 1889, being date of application in the United States.) (Complete specification.)

1302. **Improvements in means or apparatus for facilitating calculations relating to the supply of electrical energy.** Alexander Pelham Trotter, 55, Chancery-lane, London.

1306. **Improvements in galvanic dry elements.** Castle Smith, 54, Fleet-street, London. (Wilhelm Louis Frederik Hellesen, Denmark.)

JANUARY 25.

1347. **An improved fluid for primary batteries.** Theophilus Coad, 1, Quality-court, Chancery-lane.

SPECIFICATIONS PUBLISHED.

1889.

3580. **Electric bell.** Berry. 6d.

4192. **Regulator for transformed electric currents.** Siemens Bros. and Co. (Taylor). 6d.

6063. **Safety devices for electric circuits.** Lake (Thomson). 8d.

18004. **Incandescent electric lamps.** Sloan (Wilson and Brown). 6d.

18979. **Electric current regulator.** Michl. 6d.

19004. **Electric glow lamps.** White. 6d.

19216. **Generating, &c., electric currents.** Patten. 8d.

NOTES.

Telephone in Italy.—The central exchange of the Societa Telephonica Lombarda was inaugurated on the 16th ult.

Water Power.—Davenport, Indiana, has a fall of water 10,000 h.p., which it is proposed to utilise by use of electric motors.

Removal.—Messrs. Allpress and Belshaw have removed from 49, Victoria-street, Westminster, to more convenient premises, 55, Victoria-street.

Norwich.—The town of Norwich has now its properly qualified electricity company, and developments in the lighting of that place may be looked for.

Almanac of Casings.—We have received a neat almanac from Mr. Samuel Elliott, illustrated with his designs of various casings for electric light wires.

Price of Light.—From the 1st February the Edison Company of Boston charge at the rate of ½d. per 16-c.p. lamp per hour. They have 25,000 lamps on their circuits.

Contract for Ship Lighting.—The contract for fitting up the Moss line of steamers with the electric light has been secured by Messrs. J. H. Holmes and Co., of Newcastle.

Electric Tramways in Berlin.—The question of the speedy introduction of electric traction on the Berlin tramways is actively engaging the minds of the engineers and directors in that city.

Institution.—The next meeting of the Institution will take place on Thursday next at 8 p.m., when a paper will be read by Jas. Swinburne on "The Theory of Armature Reaction in Dynamos and Motors."

Military Operations.—Experiments made at Toulon with electric light projectors for use in firing heavy ordinance, have been very successful. The mark was struck every shot, at the distance of several miles.

Book Received.—We have received a copy of "Traité des Piles Electriques," by Donato Tommasi, D. ès Sc., a work of over 600 pages, illustrated, on electric batteries, published by George Carré, 58, Rue Saint-André-des-Arts, Paris.

Telephone at Tunis.—At the telephone exchange now being established in Tunis the subscribers pay a proportion of the cost of the wires at the rate of £10 per mile with a charge for installation of apparatus of £3. The subscription for two years is at the rate of £16 a year.

Statter's Constant Current Dynamos.—We understand that two of the largest dynamos that have ever been made with automatic constant-current regulation are now being constructed at the plant works of the Electrical Engineering Corporation, Limited, at West Drayton.

Iron Batteries.—M. Jablochkoff is reported as having abandoned interest in dynamos, and being seriously and assiduously studying the question of the economical generation of electrical energy by the use of iron in a primary battery, of which the construction is not yet described.

German Tramlines.—It is definitely decided to use electric traction on the new tramline. A new line of tramways is to be opened this year at Minden, Germany. It is to be hoped that electric traction will be employed. An electric line is to be built to connect Potsdam and Spandau.

Electro-Therapeutics.—A course of papers upon electricity as applied to medical treatment, by Arthur Harries, M.D., and H. Newman Lawrence, M.I.E.E., is being given in the current numbers of the *Nursing Record* under the title of "Practical Lessons in Electro-Therapeutics."

Cable v. Electricity.—The town of Minneapolis had decided to construct a cable tramway and had practically done so, but so convinced have they been of the superiority of electricity, that they have discarded nearly half a million dollars' worth of cable, and are proceeding to equip 110 miles of track for electric locomotion.

Cantor Lectures.—The fourth and last of Prof. Silvanus Thompson's lectures on "The Electromagnet" will be given before the Society of Arts on Monday next at 8 p.m. The lecture will deal with electromagnetic mechanism, range of various forms of electromagnets, plunger and coil, equalisers, and modes of preventing sparks.

Telephone between Berlin and Vienna.—According to the *Electrotechnischer Anzeiger* it is proposed to establish a telephone line between Berlin and Vienna, which would render extreme service to the business world in the two capitals. The preliminary details are all settled, and the execution of this project only awaits the consent of the two Governments.

O.S.A. Dance.—A Cinderella dance will be held by the Old Students' Association at Westminster Town Hall on Tuesday, February 25th. Tickets, 3s. 6d., may be obtained from the honorary secretary, 14, Garfield-road, S.W. These occasions of pleasurable meetings are always well appreciated, and we trust that the proposed dance may be a thorough success.

Standard Navy Fittings.—Sir William Thomson's patent compass has now been adopted as the standard compass in all the ships of the British Navy. It has also been decided to supply Sir William Thomson's sounding machines to all seagoing fighting-ships of 1,000 tons and upwards, and also to ships of less tonnage with very high speeds, of the "Rattlesnake" class.

Harrogate.—The Town Council of Harrogate have drawn up a notice of objection to the proposed application of the National Electric Lighting Company to be forwarded to the Board of Trade, stating that the Corporation themselves intend to apply for powers next session, and that they object to the right to break up streets being given to any outside company for so long a period as 42 years.

Printing by Electricity.—When are we to hear of electric motors being introduced into Fleet-street and the surrounding busy printing neighbourhood? The amount of cleanliness, comfort, and saving to printers, and revenue to the enterprising motor company, would be enormous. It can never be too persistently stated that the development and profit in motor work must eventually far outweigh that in electric lighting.

Damage to Gas Pipes.—A request has been issued by the Elektrotechnisches Verein of Berlin, which is investigating the action of lightning upon gas and water pipes, that as many cases as possible of damage so caused, or instances of the effect produced, be described to them. Communications to be sent to Prof. Dr. von Bezold, of the German Royal Meteorological Institute, addressed Schinkelplatz, No. 6, Berlin, W.

Hanover.—The number of towns in Germany which are erecting central installations for electric light on their own account has just been increased by the addition of Hanover. The local authorities have voted 1,500,000 marks for the erection of an installation, and for the purchase of the necessary land. The order for the installation, which will at first be constructed for 15,000 lamps, has been entrusted to Messrs. Schuckert and Co., Nuremburg.

Telephoning to Ships.—The steamboats entering one of the Swedish ports are immediately put into telephonic connection with the central exchange of the town, by the aid of flexible wires. It is easy to see what a wonderful convenience this would be to all concerned, and it is an example that might very well bear considerable fruit in some of our large seaport towns. We commend the idea both to the shipowners and to the telephonic companies.

Rome Tramway.—Messrs. Foot and Von Buch, who own the foreign patents of the series traction, have we understand, concluded the contract for fitting up the tramway at Rome upon that system. The line is about 1½ miles long and three cars will be supplied. The successful carrying out of this tramway may be expected to inaugurate a considerable development of electrical tramways in Italy, more particularly as water power is often available.

Electric Welding.—The War Department of the United States Government has ordered a Thomson electric welding machine for the arsenal at Troy, to be used in welding wire for the manufacture of rifled cannon. A commission has been appointed to examine the electric welding process and report upon its adaptability to the welding of boiler flues and other fittings for the Government cruisers. This commission will also test the chain welder for the navy yards.

Canadian Cables.—A Bill has been introduced into the Canadian Parliament to charter a Canada cable company for a new cable from Ireland to some point on the north shore of the Gulf of St. Lawrence, where connection will be made with the land lines. The contract is already made for a cable in London. The Canadian Pacific Railway Company's telegraph lines were on Monday completed to Halifax, and there is now direct communication by their wires from the Atlantic to the Pacific coast.

Cadiz.—Senor Francisco de la Viesca, writing from Cadiz with reference to our note upon the concession recently awarded to him for the lighting of the town, says that the statement then given, that at the end of twenty-five years the installation is to revert to the Municipality, is hardly correct. What the contract stipulates is that at the end of that time the Municipality may acquire the street lamps and apparatus, paying for them to the actual owner, which, as will be seen, is quite a different matter.

Electricity and Morals.—Rowdy quarters and new or frontier towns can do wonders for the morality of the place by the introduction of the arc light. It has been recently noticed that in the best lighted towns the decrease in crimes, especially those of violence and robbery from the person, has greatly decreased. The attention of the authorities in new colonial or mining towns and other places of that description should be emphatically directed to this point, a very important one to the guider of local matters.

Bolton.—The Gas and Lighting Committee to the Bolton Town Council recommended that it was highly important to public interests that the power to supply electricity for lighting should be in the hands of the Corporation, and that application for such power should be made as soon as a reasonable and sufficient demand for the same arises. Some animadversion arose from the fact that the Council owned the large property of £600,000 in the gas works; but in the end the recommendation of the committee was adopted.

Exhibition of Meteorological Instruments.—The council of the Royal Meteorological Society have arranged to hold at 25, Great George-street, Westminster, on March 18th to 21st next, an exhibition of instruments and photographs illustrating the application of photography to meteorology. The Exhibition Committee invite applications not later than February 12, and will also be glad to show any *new* meteorological instruments or apparatus invented, or first constructed, since last March; as well as photographs and drawings possessing meteorological interest.

Turning-Lathes.—We have received a copy of "Turning-Lathes," by James Lukin, B.A. (Britannia Company, Colchester), a manual for technical schools and apprentices, with 194 illustrations. The work is in its third edition, a proof in itself of its acceptability. Many electrical students find a knowledge of lathe-work of utmost utility to them; and for these this handbook—starting from the beginning and explaining fully and with straightforward directions lathe-work, from wood to screw-cutting and metal-spinning—will prove an exceedingly useful companion.

Tenders for Berne.—The Municipality of Berne has opened a competition for the supply of electric lighting to certain parts of the city. Those only may enter who are either Swiss manufacturers or representatives of foreign firms living in Switzerland. Two new turbines, of a total of 220 h.p., are also erected and ready to work. The gas company and the municipal water works department will furnish to applicants the scale of charges, as well as plans of the town, and all other information. The tenders must be submitted before the 15th February next to M. Hodler, director of municipal works at Berne.

Arc Carbon Refuse.—A curious point has been raised in the courts with reference to the ashes from arc carbons. Mr. Bridge, the magistrate at Bow-street, decided that the ashes produced in the manufacture of the electric light at the Hotel Metropole were not trade refuse, and that the Vestry were bound to remove them. He refused to state a case for the opinion of the High Court, but the Vestry appealed. Lord Justice Fry and Mr. Justice Mathew, on Wednesday, held that the magistrate's opinion was not conclusive, as a question of law, as well as one of fact, was involved. A rule absolute to the magistrate was therefore granted.

Prices of Arc Lighting.—At Alliance, Ohio, the Thomson-Houston and the Western Electric Companies divide a contract for the public lighting. The contract is for 2,000-c.p. arc lights, to burn till midnight every night at the rate of 6dols. per month (25s.), or £15 per year. At Urbana, O., the Western Company has a contract for 50 2,000-c.p. arcs for five years, to burn every night at 85dols. per light (£17. 14s.). At Boston, Mass., the superintendent of lamps has just received bids for the electric lighting which equal for the city district £8. 6s. for five years; for outlying districts £8 one or three, and £7. 6s. for five years contract.

Brussels.—The Electrical Commission at Brussels has decided to recommend to the Municipal Council the acceptance of the tenders for the supply of electric light

These tenders, based upon the scale of charges drawn up by the commission, are those of the Société International d'Electricité de Liége, working together with MM. Cassel et Cie., of Brussels, Siemens and Halske, and the Allgemeine Gesellschaft, of Berlin, for the centre of the town. The concession for the other part of the town will be given to M. Van Rysselberghe, comprising the quartier Notre Dame aux Nieges, the quartier Léopold, the avenue Louise, and a portion of the south of the town.

Theatrical Fairy Lamps.—The use of small electric fairy lamps in ballets has been attended with a good deal of success—the only difficulty incurred was the proper disposition of the small batteries and accumulators, which might not improbably sometimes spill over and burn the clothes, not to say the fair skins of the dancers. A variation of the fairy lamp effect has been attempted, in which the batteries are done away with and the current is supplied on the alternating system. The primary is led to coils beneath the stage and in the heel of the shoes a small secondary coil is fitted. On dancing or standing over the primary the lights flash up with bewildering and fascinating effect.

North Berwick.—At the monthly meeting of the North Berwick Town Council on Monday, the clerk submitted further correspondence with the electric lighting company with which the Board had been communicating. The letter referred to details of the scheme of electric lighting which the company propose to introduce into the town in the event of a satisfactory arrangement with the Council in obtaining their consent to apply to the Board of Trade for the necessary powers. On consideration, the Board agreed to delay taking any step in the matter till next meeting. This delay will allow of further communication with the electric lighting company in order to obtain more definite information on the scheme.

A Real Electric Railway.—It is time we began hearing of a real railway driven by electricity—not a tramline a few miles long, but a serious railway undertaking. Here is the item—of course it is from America: An electric railway, 250 miles long, to run from Atlanta to Savannah, has been planned; the electricity is to be generated in a novel way, by utilising power from the rivers along the route. The enterprise opens out many possibilities, and serves to indicate that in the future the course of railways may be guided by the direction and extent of the river power, not less than that of easy gradients. The proposal, if a practical one, is one of the most important that has recently been discussed.

Sutton, Southcoates, and Drypool.—The Electric Lighting Committee of the Hull Corporation yesterday week had under consideration the Bill of the Sutton, Southcoates, and Drypool Gas Company, in which they seek for electric lighting powers. The chairman and the deputy-chairman were both in favour of opposing the Bill, believing that healthy competition would be beneficial to the district; and considering that, if they allowed powers to be given to one company, they ought to sanction the same privileges being afforded to the British and the Kingston Gas Companies. However, after some discussion, the committee decided to recommend the Council, subject to proper conditions, not to oppose the Bill.

Tenders for Homerton Workhouse.—The Guardians of the Hackney Union are asking for tenders for a complete installation of electric light for lighting the workhouse extension, infirmary, pavilion and board-room, and offices at Homerton. Persons desiring to tender may obtain specifications, conditions of contract, and form of tender by applying to Mr. Walter Barnett, surveyor, Winchester House, Old Broad-street, E.C., and paying a deposit, which will be returned to persons sending bona fide tenders in the manner and at the time specified. The contractor will be required to give approved security for the due performance of the contract. Sealed tenders, endorsed "Electric Lighting," must be delivered at the office of Mr. J. Owen Perry, clerk, Homerton, N.E., by 1.45 p.m. on 12th inst.

Dynamo Improvements.—Among the minor improvements which go to make the dynamo a practical piece of engineering which have recently been introduced by various makers, may be mentioned the following points: a spun and balanced brass cap attached to the armature between the commutator and the fixed pole pieces, revolving with the armature and tending to keep out dust; a flat air-space clean through the field-magnets between the core and the coils to keep these latter cool on the inside as well as the outside; terminals on high-tension machines one only on each side of the dynamo, rendering it a physical impossibility for an attendant to touch both at one time; polished wood panels or other protection to exterior coils of field-magnets, to give a finished and workmanlike appearance and prevent the coils from injury.

Members and the Electric Light.—The electric lighting at the House of Commons has not progressed as well as some people would desire, and the reason is entirely *sui generis.* When Mr. Shaw Lefevre attempted to introduce the light it proved a failure because the member's faces were shadowed by the vertical light, so that under shadow of their hats they became indistinguishable to another, and standing in some positions the individuality of speakers could only be guessed at in the reporters' gallery. The reason stated does not seem difficult of correction—a proper distribution of electric standards on a lower level would suffice; but the engineers who lay out further installations in the House would evidently do well to remember that an M.P. should, of all things, have his individuality placed in a physically strong light, as it is usually supposed to be, in a moral or political one.

Rebuilding the Edison Station.—Mr. Edison, in an interesting letter to a correspondent in Paris, says, in reference to the recent fire at the Pearl-street station: "The fire occurred on a Thursday, and completely destroyed the station. On Saturday the men were got to work, and on the Saturday following the current was again supplied at Pearl-street to the 20,000 lamps served by the old station. This *tour de force* was accomplished in six days of twenty-four hours. Would you be capable in Paris," he asks, "of doing the same there? The loss will not be very great, as the damage is amply covered by insurance, and the cost of maintenance in the new station will be 30 per cent. less." Certainly they could do the same, adds the receiver of this letter, and the French electricians have proved as much already in the Paris Exhibition. It will, we think, be acknowledged, whoever carried it out, that it was a pretty smart piece of work.

Ship Lighting.—The two desiderata in electric lighting plants for ship lighting with equal efficiency and trustworthiness are small size and corresponding economy. A special electric lighting set for ship lighting has been designed by Mr. J. A. M'Mullen, electrical engineer, 8, Princes-street, Westminster, S.W., of which the following particulars are given: the machinery is capable of working 80 16-c.p. lamps, and occupies a space of about 4ft. 6in. by 3ft., the first cost being not much over a hundred pounds. The engine runs at about 200 revolutions per minute, and the dynamo at 700, both of which speeds give great efficiency without any undue wear and tear. The dynamo is coupled to the engine by means of a specially designed link belt, and by the arrangement of a third pulley on the far side of the dynamo, which actually touches the engine, a powerful grip is secured on the dynamo pulley, and there is no slipping, even though the space is so small.

Commissioners of Sewers.—On Tuesday the first meeting of the new Commission of Sewers of the City of London was opened at the Guildhall by the Lord Mayor. Mr. Frank Green was elected chairman for the ensuing year. The various officers of the Commission were reappointed. A petition was presented from owners of land and property and lessees and occupiers of houses in Holborn, Cheapside, King William-street, etc., against the Central London Railway scheme, on the ground of the injury it would occasion them, and the enormous inconvenience which it was feared would result to the public. On the motion of Mr. W. H. Pannell, the petition was referred to the Finance and Improvement Committee to consider and report. A letter from the Brush Electrical Engineering Company, asking that the western division of the City might be included in their electric lighting contract as well as the central, was referred to a committee.

Tenders for Barnsley.—The Barnsley Town Council are seriously contemplating the introduction of the electric light, and it will be seen from their advertisement they now invite proposals from electric lighting companies for the establishment in Barnsley of an electric lighting plant, and the supply of the electric light both for public and private purposes within the borough, in accordance with the Electric Lighting Acts, 1882 and 1888, and the provisions of the Barnsley Electric Lighting Provisional Order when obtained. Maps of the borough, with copies of the form of proposal and conditions, and of the draft provisional order, together with other information, may be obtained on the personal application of a representative of any electric lighting company to Mr. J. Henry Taylor, C.E., borough surveyor, Barnsley, or to Mr. Henry Horsfield, town clerk, Church-street, Barnsley. Proposals, properly sealed and endorsed, must be delivered to the town clerk by 10 a.m. on 28th inst.

Life of Incandescent Lamps.—With reference to our remark last week upon the condition of incandescent lamps after the long runs mentioned as having taken place at Broomhill, Sir David Salomons sends us one of the lamps by which he read our article, taken at random from its fitting in Lady Salomons' boudoir. This lamp has been in use, with others, in the room for at least three years, and has run certainly 3,400 hours, and 3,700 hours is, he says, probably nearer to the truth. All his lamps at present in daily use have run about this time. The lamp is a 100-volt 16-c.p. Edison-Swan lamp, obscured. It is certainly in very good condition; one can, of course, tell it has been run, and that it is not a new lamp, and on close inspection one can notice a slight dingy appearance on the glass, but the "blackening" is very slight, and it has evidently many hundreds of hours to run before its "life" is extinct. Sir David mentions that the new lamp put in its place certainly gives more light. The old one, however, may be regarded as a good serviceable lamp, and has dulled so gradually that they have not noticed the loss of light. At his house on the Grosvenor alternate-current circuit with 95 volts he finds that 20 hours or so blacken the lamps more than the one sent.

North Metropolitan.—The extent to which electric traction will before long be introduced in London may be judged from the fact that the North Metropolitan Tramway Company, in their report, state that they have now a stud of 3,126 horses, and that during the last twelve months they have carried a grand total of 66,458,568 passengers. After the complete success of the trial of accumulator cars at Barking-road, where the cost is ascertained to be at least ¾d. per car mile less than horse traction (and on an unfavourable route), it is expected to make an immense saving by the introduction of electricity on all their lines, and a Bill is being pressed forward for this purpose in Parliament. The status of the electric car in England may now be considered secure. Other companies will follow suit, and, as with electric lighting, the eventual state of the mother country will not be found behind that of the States, with the double advantage of having a practically thorough and perfect system, not requiring to be altered after a year's use, and without the constant unsightliness of long lines of electric wire posts.

Southwark Electric Railway.—The report of the directors of the City of London and Southwark Subway Company states that during the past half-year the works of the subway have made considerable progress, and are now approaching completion. One of the tunnels is now completed throughout, and the other tunnel is being rapidly advanced. The underground stations are all nearly finished, and the station buildings on the surface at Great Dover-street are roofed in, the alterations to the building at King William-street have been completed, and the company's offices are now established there. Messrs. Mather and Platt have had an electric locomotive and carriages running experimentally for some time between the King William-street and Great Dover-street Stations. As the present authorised lines stop at Stockwell, about a mile short of the great centre of traffic meeting near The Plough at Clapham, the directors have deemed it advisable to deposit a Bill in Parliament asking for power to extend the line to that point, the works for which can be carried out at a lower comparative cost than the existing works, and the approval of the proprietors will be asked at a special meeting called for that purpose. They propose also to alter the name of the company to that of the City and South of London Railway Company, as being more in harmony with the present nature and object of the undertaking.

Bridlington.—The action taken by the Local Board at its meeting last week opens up the grave possibility of the town being without the means of public lighting after the expiration of the present contract for gas on the 25th proximo. Tenders had been advertised for the lighting of the district either by gas or electricity. Two tenders had been received—one from the gas company, offering to light by gas at 35s. 6d. per lamp for 1,200 hours, and the other from Messrs. Laing, Wharton, and Down, on the Thomson-Houston system, who would put down 28 arc lamps of 1,200 c.p. and 160 Edison-Swan incandescent lights of 16 c.p. for £900 a a year on a contract for five years. Dr. Redman, in moving that the electric light be adopted, submitted that £800 a year was now paid for about 5,000 c.p., and for the outlay of an additional £100 a year they would get 60,000 c.p. Mr. Creaser rose to move that the gas company's tender be accepted, but it was ruled that, being a considerable shareholder in the company, he could not do so. It was, however, moved as an amendment by Mr. Hesselton. The question then arose as to the legality of gas shareholders voting on the question, and it was held that whilst they could not vote in favour of the gas company's tender, they were not debarred from voting against the electric light. The amendment, being only supported by three votes against four, was declared lost. The original motion was supported by four votes, and six (including three gas shareholders) were recorded against it. This also was declared lost. Both tenders were thus rejected, and if some arrangement be not entered into before the expiration of the present contract for gas, the town will be left in darkness.

Council of the Institution of Electrical Engineers.—The *Journal* of Institution of Electrical Engineers just issued contains the report of the council for the past year, and the continuation of the interesting discussion on Mr. Addenbrooke's paper on "Electrical Engineering in America. The council have awarded the annual premiums in respect to papers read during the year ending 31st May last as follows: The Institution Premium, value £10, to W. M. Mordey, member, for his paper on "Alternate-Current Working"; the Paris Electrical Exhibition Premium, value £5, to Dr. Oliver Lodge, F.R.S., member, for his paper on "Lightning, Lightning Conductors, and Lightning Protectors"; the Fahie Premium, value £5, to A. E. Kennelly, associate, for his paper on "Certain Phenomena connected with Imperfect Earth in Telegraph Circuits." The council report that after the consultation of the Board of Trade with the Institution, in the early part of the year, on certain technical points, a special committee was formed, and their recommendations, of which the most important was the question of regulations for overhead wires, was substantially adopted by the department. The council also reappointed the Standardising Committee to confer with the Electrical Trades Section of the London Chamber of Commerce, and a draft scheme was conjointly drawn up and submitted to the President of the Board of Trade. There is every reason to hope that this recommendation, which has already been practically adopted, will eventually be fully carried out, and thus render unnecessary any other standardising establishment, which, however well organised and under whatever influential auspices it might be created, could scarcely expect to meet with the general recognition which a Government establishment must necessarily command. With reference to the resumption of the old system of election of the members of the council, with a view of effecting a complete though gradual change in the composition of that body, it has been resolved on the initiation of Prof. Forbes that two at least of the retiring members each year shall be those who have served during the longest time on the council. Prof. Forbes and Dr. Fleming have accordingly retired, and Mr. Stroh, with the same object in view, had already pressed his resignation, which was therefore accepted. The financial position of the Institution continues in a sound condition, the increase of members more than compensating for increase in expenditure incurred by the wider field of its operations.

Effect of Lightning on Underground Wire Ropes.—Mr. W. S. Harris, of Kibblesworth Colliery, contributes a curious and interesting account to the *Journal* of the British Society of Mining Students of the effect of a thunderstorm upon an underground rope at the colliery on the 23rd of July last. A sharp thunderstorm occurred, lasting a couple of hours, accompanied by heavy rain. The shaft is 60 fathoms deep, and the rope affected is a self-acting endless iron rope 2¼in. diameter, unconnected with any other rope. The tubs are hooked to it by eyes, the incline giving the motion. The rope usually travels at 1½ miles an hour. A lad at the end wheel unhooks the full tubs, and hooks on the empty ones. The rope, which is little more than 1,900 yards in length, is supported by a wheel each end, by the 80 tubs, and by eight sheaves, making in all 90 supports and connections to earth. During the thunderstorm the rope suddenly became charged with electricity. The brake lad felt strange sensations in the hand on the brake-handle and in his legs—he was standing on damp wood, but clear of the rails. The shocks were intermittent, and only slight at first, so that he was able to touch the brake or rope when necessary. In a few minutes, however, the rope gradually slackened its speed and then stopped, although he put the brake right off. This stoppage was apparently accounted for by a full tub which was found off the way, and the waggon-way man lifted it on the rails with the aid of a lad, both receiving shocks; they then went to the brakewheel, expecting that the rope would move, for all else was right: the rope, however, would still not move; they pulled on it for a quarter of an hour, and it moved a yard and stopped again. They went along and found a full tub "ended up" on the rails; they replaced this, again feeling shocks. They then telephoned to the lad at the bottom to sway on the rope while they did the same, and all worked for a quarter of an hour with no result. Then they desisted, and whilst considering what to try next, within five minutes, when no one was touching the rope, it gently moved away as if nothing had been wrong, and continued without further trouble. The time was then 3.45 p.m., and by this time the thunderstorm was over and no more shocks were received. When swaying on the rope those who had hold of it let go at each shock, and, for the moment, the electricity seemed to be all discharged, for, on touching immediately after a shock, nothing could be felt, although in a few seconds more came another and so on at intervals of about a minute, at the end of the hour and half being weaker and less frequent. The electric bells all worked correctly during this disturbance. Another endless rope was not affected, but continued running; no shocks were received from it; and no lightning was seen by anyone in the pit. This seems to show, says Mr. Harris, that the electric current did not descend by the shaft, but more probably was produced in the rope by induction from the earth in its becoming highly charged with electricity at the commencement of the thunderstorm; but it seems strange that the rope, which is by no means insulated, could retain the electricity for any appreciable time. The case, as related above, is extremely interesting and instructive for the student of statical electricity. It seems pretty clear to us that the explanation is that the rope was affected, not by the earth's electricity at the commencement of the storm, and afterwards slowly discharged, but that it suffered induction—in common with the earth—from the clouds, and as each flash took place the charge in the rope was liberated through the most convenient point of contact.

ON GALVANOMETERS.*

In fitting up the laboratories of the Central Institution the authors have had occasion to obtain many galvanometers of various types, several of which are comparatively new. The results obtained from the comparison of the different instruments will, it is hoped, be of service in judging their relative excellence, and in suggesting further improvements.

The authors give two reasons for their opinion that sensitive galvanometers should be made astatic. Firstly, by so doing the working of the galvanometer is made more independent of outside magnetic disturbances; secondly, although both astatic and non-astatic galvanometers can theoretically be made infinitely sensitive by sufficiently weakening the controlling field, the practical limit caused by instability is reached sooner with non-astatic instruments than with astatic ones. The usual method of placing the mirror inside the coil is undesirable. In some instruments shown at the meeting Mudford's improvement of placing the mirror outside the coil, or outside between the two pairs of coils when four coils are employed, had been adopted. The valuable parts of the coil near the suspended needle could thus be utilised. It was shown, however, that there was a small, approximately, spheroidal space near the needle within which the convolutions would tend to oppose those in the more distant portions of the coil. A graphical method was given for determining this space, which space it is proposed to utilise by winding the convolutions within it in the opposite direction to that of the remaining ones of the coil. Details as to the methods of supporting the coils were then discussed, and the importance of fitting them in boxes mounted on hinges or otherwise, so as to be readily removable, was pointed out. A galvanometer devised for teaching purposes and provided with variable damping arrangement was described, in which the damping is effected by enclosing the mirror in a glass cell, whose sides can be caused to approach or recede by turning a milled head outside the instrument. This arrangement enables the damping to be varied between wide limits, and its effect on the swing produced by a given discharge can be determined. The instrument is also serviceable both as an ordinary damped galvanometer or as a fairly ballistic one.

In measuring quantities of electricity by the first swing of a galvanometer needle, a correction has usually to be introduced for damping. This correcting factor is simple enough when the damping is small, but becomes more complex as the damping increases, and to facilitate the calculations a table of values of the factor for various values of λ (the logarithmic decrement) has been calculated. From this it appears that for values of λ less than 0·5 the value of the factor is very nearly $(1 + \frac{1}{2} \lambda)$, the correction usually applied. Improvements in methods of insulating the coils and terminals of galvanometers required for insulation tests were next described, the principle of which may be gathered from Figs. 107 and 108 in Prof. Ayrton's "Practical Electricity." A special form of instrument for high insulation work was exhibited, in which the copper resistance of the coils is nearly 400,000 ohms, and the shortest path along which surface leakage can take place from the coils to the base of the instrument is between 30in. and 40in. of ebonite artificially dried by sulphuric acid. This is attained by supporting the coils from two corrugated ebonite rods which depend from a brass ring carried on the top of three corrugated pillars fixed to the base plate. The instrument was constructed to drawing by Messrs. Nalder Bros., but the method of supporting the coils was suggested by Messrs. Eidsforth and Mudford.

With reference to the proportionality of deflection to current in reflecting galvanometers it was pointed out that ordinary reflecting galvanometers may differ more than 1 per cent. within the limits of the scale, hence showing the necessity for calibration when any approach to accuracy is desired. Galvanometers of the D'Arsonval type sometimes differ from proportionality more than the one above referred to, but by fitting such instruments with curved pole-pieces, and allowing the coil to hang freely from the top suspension, a proportionality true to less than 0·15 per cent. has been attained over a scale about 30in. long. The following abstract of tests made indicate the amount of error which may arise:

Ordinary Reflecting Galvanometer.

Deflection................................	0	120	240	360	480	600
Corresponding current	0	121·0	242·5	363·5	483	600

Ordinary D'Arsonval Galvanometer.

Deflection..........................	0	120	240	360	480	600
Corresponding current	0	118·5	240·6	359·8	473·5	600

D'Arsonval Galvanometer with Curved Pole-pieces and Coil Hanging Freely at the Bottom.

Deflection...........................	0	120	240	360	480	600
Corresponding current	0	119·9	239·9	360·2	480·7	600

Coming to the question of sensitiveness, the importance of keeping the wire as close as possible to the magnets was brought prominently forward, as well as the necessity of reducing the "figure of merit" of various instruments to the same standard in comparing their sensibilities. A satisfactory standard of comparison is, however, not easy to determine. The sensibility in use of any instrument is made up of many factors, some of which arise from the skill of the experimenter himself. It is also desirable to give the data in such a way that the influence of each factor can be separately determined. The authors have therefore endeavoured to distinguish as far as possible the three chief causes of the sensibility of reflecting galvanometers—viz., the arrangement and winding of the coils, the construction of the magnetic system, and the optical method of magnifying the angular deflection produced. With the same view the question of the susceptibility of various galvanometers to outside magnetic disturbances has been considered separately, since, first, the electrical qualities of the instrument are not altered by such disturbances, and, secondly, their influence is dependent, not only on the kind of instrument, but on the place of test. Galvanometers have, therefore, been classified in four divisions, according to their relative sensitiveness to slight variations of controlling field. The strength of the controlling field is supposed to be so adjusted that the returning moment arising from twisting the suspended parts through a unit angle from the equilibrium position is constant. The four classes, arranged in order of decreasing susceptibility, then comprise non-astatic galvanometers working in a weak field and with strongly magnetised needles; non-astatic instruments working in a strong field and with needles not so strongly magnetised; astatic galvanometers working in a fairly strong field; and, lastly, galvanometers of the D'Arsonval type working in an extremely strong field. The optical sensitiveness of a galvanometer is dependent on many considerations which have no connection with the instrument itself. Thus the goodness of the mirror, the distance of the scale, etc., are important factors. The authors have hence contented themselves with giving the number of scale divisions per micro-ampere or per micro-coulomb, assuming the scale to be placed at a distance from the mirror equal to 2,000 scale divisions. As the scale distance most generally used is a metre, and as the scale divisions are frequently in half-millimetres, the conditions assumed are often fulfilled in practice. The sensibilities for a steady current and for a discharge are thus directly expressed in angular measure irrespective of optical magnification. The sensibility at the usual scale distance employed with each instrument is, however, given as a guide, for it must be remembered, in comparing sensibilities at the same period, that two instruments will differ although identical in all respects save the moment of inertia of the suspended parts, and these may differ because a larger and heavier mirror has been attached in order to employ a longer scale distance. An important and difficult question is whether the factor of merit of a galvanometer should be given under the condition of constant period, or of constant controlling moment, or of constant controlling field. The first is the easiest to obtain and to calculate from, and is most readily understood. In the table of data of the many instruments tested, only an abstract of which is here published, two columns have therefore been reserved for the values of D and S, which respectively denote the deflection per micro-ampere and the swing per micro-coulomb, each in scale divisions when the period is 10 seconds and the scale distance is 2,000 scale divisions. The corresponding values at any other period, T, are, of course, $D T^2/100$ and $S T/10$. It is, however, unfair to judge the relative merit of two instruments by simply comparing their action when the period is 10 seconds in each case, for this period may be unsuitable for use with one or both of them. It is, moreover, not quite right to compare the values of D and S when the usual periods are employed, as these may not be all equally favourable to the instruments considered. The authors therefore determined to reduce the numbers to their corresponding values under the conditions of constant controlling moment per unit angle. The alternative of constant controlling field was rejected because it is inapplicable to instruments of the D'Arsonval type. The stability of the zero of any instrument, however, depends on the controlling moment per unit angle, and the values of D and S (see table) have therefore been multiplied respectively by I and $\sqrt{I}$, where I is the moment of inertia of the suspended parts in C.G.S. units. In this manner numbers proportional to the sensibilities for constant controlling moment have been obtained, and these, perhaps, give a fair comparison between the various instruments when the time required to take an observation is entirely unimportant. It should be born in mind, however, that the period of instruments in which the moments of inertia of the suspended parts are large, such as Rosenthal, Gray, or ordinary D'Arsonval galvanometers, would be inconveniently long.

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*Abstract of paper by Prof. W. E. Ayrton, F.R.S., T. Mather, and W. E. Sumpner, D.Sc., read before the Physical Society, Jan. 17th, 1890.

The influence of resistance has next to be considered. If two galvanometers differ only in the gauges of wire with which they are wound, and the convolutions are similarly distributed, then the sensibilities should be proportional to the number of turns. If, again, the thickness of the insulating covering bears a constant proportion to that of the wire, then the resistance of the coils would be proportional to the square of the number of turns, so that the values of $D/r^{\frac{1}{2}}$, $S/r^{\frac{1}{2}}$ would be constant for the same pattern of instrument, where D and S are the number of scale divisions per micro-ampere and micro-coulomb respectively, and r is the resistance of the galvanometer. The proportion in question, however, varies not only for coils of different resistances, but also in the same coil, for several different gauges are generally used in winding the various portions. To get some idea of the relation between resistance and sensibility, the authors have made tests on galvanometers of the same pattern, but of different resistances (the same magnetic system being used throughout), and have found that D and S vary approximately with the value of r raised to the power 2/5—*i.e.*, $D/r^{\frac{2}{5}}$ and $S/r^{\frac{2}{5}}$ are approximately constants for galvanometers of the same pattern. These quantities have accordingly been taken as the factors of merit of the galvanometers for constant period, and their values are given in the table (*see* columns 10 and 11).

Another question to be considered is the factor of merit in connection with the volume of the coils, as this is important as regards the cost of high-resistance galvanometers. A separate column (5) is therefore given showing the approximate volume occupied by the wire in each instrument, and other columns (14, 15, 16, 17) give the values obtained by dividing this quantity into the various factors of merit. The results of comparison in these latter columns are very interesting. It appears that galvanometers of the Rosenthal or Gray and the D'Arsonval types are by far the most sensitive in proportion to the volume of coil. The authors believe that the best way to make a very sensitive galvanometer with a movable magnetic system is to employ several small coils instead of one or two large ones,* and that the magnets should be horseshoe-shaped with the line joining the poles vertical, as in Prof. Gray's instrument, but modified so as to give smaller moment of inertia. Such a magnetic system can be made very delicately astatic, and the weakening of the magnets with time does not greatly influence the astaticism. The authors also conclude from their investigations that the most sensitive galvanometer of all would be one of the D'Arsonval type suitably modified. The poles of the magnet should be very close together, the coil should

ABSTRACT OF TABLE.

	Type.	Description.	1 r	2 M	3 D	4 S	5 V	6 I	7 D I	8 $S I^{\frac{1}{2}}$	9 $D/r^{\frac{1}{2}}$	10 $D/r^{\frac{2}{5}}$	11 $S/r^{\frac{2}{5}}$	12 $D I/r^{\frac{2}{5}}$	13 $S I^{\frac{1}{2}}/r^{\frac{2}{5}}$	14 $D/r^{\frac{2}{5}}V$	15 $S/r^{\frac{2}{5}}V$	16 $D I/r^{\frac{2}{5}}V$	17 $S I^{\frac{1}{2}}/r^{\frac{2}{5}}$
1	Thomson single coil	Tripod pattern (Finsbury Technical College)	0·6	3·8	7·6	...	...	...	...	...	10	9·4	5·9	...	...	...	...	...	...
2	,, double ,, ...	Glass cylinder pattern ,, ,, ...	4,600	1,220	2,440	1,520*	...	...	...	...	53	76	5·2	...	...	...	...	...	...
3	,, ,, ,, ...	Elliott's stock pattern†	7,000	4,300	7,110	4,450*	30	0·013	92	507	85	205	129	2·68	14·7	6·8	4·3	0·069	0·049
4	,, ,, ,, ...	,, larger coil pattern†	12,300	7,680	15,200	9,550*	240	0·013	196	1,090	137	350	220	4·53	25·2	1·39	0·88	0·018	0·10
5	,, ,, ,, ...	,, ,, ,, †	30,000	10,710	21,800	13,700*	240	0·013	284	1,560	126	353	220	4·6	25·3	1·40	0·88	0·018	0·10
6		Prof. Langley's bolometer galvanometer	20	125	250	156*	...	...	...	...	56	76	47	..	...	...	...	...	...
7	Mudford improved single coil	Foster bridge galvanometer (Central Institution) ...	26	347	349	220*	72	0·035	12	41	68·5	94·4	60	3·26	11·1	1·30	0·82	0·046	0·15
8	,, ,, ,, ,,	Gal. for E.M.F. of cells by condenser method (C.I.)	2,457	1,375	2,160	1,360*	72	0·035	76	259	43·5	95·5	60	3·34	11·2	1·32	0·83	0·046	0·15
9	,, ,, ,, ,,	Gal. for E.M.F. of cells by Poggendorff's method (C.I.)	6,410	2,720	3,360	2,110*	72	0·035	118	396	42	101	63	3·54	11·8	1·31	0·87	0·049	0·16
10	,, ,, double ,,	Wheatstone bridge gal. (Finsbury Technical College)	700	1,720	2,970	...	...	...	...	...	112	198	136	...	...	...	...	...	...
11	,, ,, ,,	,, ,, (Central Institution)	686	1,660	1,600	1,010*	88	0·084	134	293	61	112	74	9·41	21·5	1·25	0·78	0·059	0·36
12	,, ,, ,, (large)	Variable damping ,, ,, ,,	9,744	4,200	4,280	2,640	200	0·052	222	615	43·5	108	67	5·61	15·3	0·54	0·34	0·011	12·3
13	,, ,, ,, ,,	High resistance ,, ,, ,,	360,000	50,000	54,200	34,000*	236	0·01	542	3,400	90	324	202	3·24	20·2	1·37	0·86	0·014	0·086
14	Rayleigh, Gray, or Rosenthal two coils	Rosenthal micro- ,, ,, non-astatic	44	22·9	25·4	16	0·29	1·5	38	31	3·82	5·6	3·5	8·40	4·3	14·7	9·2	15·0	18·0
15		,, ,, ,, ,, astatic	44	25	27·7	17·4	0·29	0·70	19·4	23	4·2	6·1	3·8	4·27	3·2	16	10·3	7·8	13·4
16	,, ,, four ,,	Messrs. T. and A. Gray's instrument	30,000	32	64	40*	51	29	1,860	215	0·37	1·04	0·6	3·01	3·2	0·02	0·013	0·203	0·11
17	,, ,, ,, ,,	Ballistic galvanometer (Central Institution)	4,090	54	63	39·2	...	...	...	...	1·0	2·26	1·4	...	..	...	...	...	...
18	Depretz-D'Arsonval	Carpentier's ordinary make (Crompton's)	208	286	375	236*	...	...	...	...	26	44·3	27·9	...	...	...	...	...	...
19	,, ,, ...	John's make, low resistance (Central Institution) ...	3·8	39	42	26·4*	0·60	5·5	230	62	21·5	25	15·5	13·4	36	41	26	22	60
20	,, Invariable sensibility	Home made (Central Institution)	21	190	181	114*	0·96	13	2,360	410	39·4	54	33·6	700	122	56	35	730	127

EXPLANATION OF TABLE.

r = resistance of ohms.
M = millimetres deflection per micro-ampere when the period is 10 seconds and the scale is placed as in the actual use of the instrument.
D = deflection in divisions per micro-ampere when the period is 10 seconds and the scale distance is equal to 2,000 scale divisions.
S = swing produced per micro-coulomb under the same conditions as above.
I = moment of inertia of suspended parts in C.G.S. units (only approximate).
V = volume occupied by the convolutions of wire (only approximate).
* These numbers are calculated from the corresponding values of D.
† The constants of these instruments were kindly supplied by the makers.

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* Mr. C. V. Boys, F.R.S., in his Cantor Lectures on instruments for measuring radiant heat (April, 1889), has also shown that galvanometers with small coils may be made very sensitive (p. 22, 23).

be very small, and no iron core should be used. The sensitiveness could be further increased by employing electro-magnets instead of permanent ones to produce the deflecting field.

Experiments have also been made on the coefficients of self-induction of galvanometer coils, and a table of values is given in the paper. From this it appears that a coil of ordinary size used in Thomson galvanometers has a coefficient approximately equal, numerically, to one-thousandth of its resistance in ohms. If the coils of the instrument are in series and placed near each other, as in actual use, the coefficient is increased by about half its former amount, owing to mutual induction, so that for Thomson galvanometers whose resistance vary between 1,000 and 10,000 ohms the time constant is about 0·0015 seconds. Very high-resistance instruments have a smaller time constant, owing to the increasing importance of the insulating covering of the wires. The authors also discuss the possibility of judging the electrical qualities of galvanometer coils by measurements of their induction coefficients.

The importance of having the magnets of galvanometers as strongly magnetised as possible is illustrated in a table showing the results of experiments made at the Central Institution. In many cases the sensibility of an instrument has been trebled (for the same periodic time of vibration) by simply remagnetising the needles, and in one case the sensibility of an instrument had fallen to one-fifth its original value by the weakening of the magnets with time and use. The experiments show that, however carefully a galvanometer may be used, it is advisable to remagnetise the magnets occasionally.

In view of Mr. Preece's remarks at the Institution of Electrical Engineers on January 23, on the deteriorating quality of magnet steel, it is of the first importance that, for sensitive galvanometer needles, only the very best quality obtainable should be employed.

THE FIRST PRINCIPLES OF ELECTRICAL ENGINEERING.

(Continued from page 85.)

Culling once more from the book referred to in our last issue, a perfectly definite stand is made, which, if tenable, will do much towards simplifying from an engineering point of view the ideas which exist upon electric and magnetic interactions. The electric and the magnetic circuits are really both similar, and might almost be dealt with as different phases of one circuit. Every so-called line of force, whether from a magnetic source or from an electrical source, is dealt with as a closed curve. In the conductive circuit there are two sets of closed curves seemingly acting at right angles to one another. There is, for example, the set which gives the phenomena of the current acting parallel to the axis of the conductor, and there is the set acting at right angles to these. Every conductive circuit is a magnet of one loop. A magnet is but a succession of such loops, acting in series, each increasing the magneto-motive force that sends the loops around the coils, till, when we get a "coil" magnet, the phenomena seem to be just the opposite to those that appear in the conductive circuit; tor now the loops go through the coil parallel to its axis, returning to form the closed curves on the outside of the coils. These loops form what may be termed the utilisable part of the magnetic circuit, while what we generally term current forms the utilisable part of the conductive circuit.

There is one conspicuous difference, however, between the conductive and magnetic circuits. If the coil magnet be continued till the successive coils make a complete ring, there is no manifestation of available loops—they seem to vanish. In reality they form the closed curves or loops in the interior of the ring.

Every calculation almost connected with engineering electrical apparatus depends upon a knowledge of these loops.

If we bring a conductor into the field of these loops, a current is set up exactly in proportion to the number of loops that pass around the conductor.

The strength of an electromagnet depends altogether upon the number of loops that pass through it.

The pull of an electromagnet depends upon the number of loops going through the armature from one pole and returning through the other pole.

No two loops can occupy the same space, hence when we try to force loops of similar polarities into the same space we get the phenomenon of repulsion, which is just the same as trying to put a hammer and a piece of glass into the same space. The repulsion in that case is proportional to the force with which the attempt is made. There is absolutely no single phenomenon in electric or magnetic circuits which, granting these premises, can be termed repulsive.

Electrical attractions arise because of the polar conditions of the loops tending to shorten the loops, and this tendency to shortening gives rise to the phenomenon of attraction.

There is something which appeals more forcibly to endorse the correctness of these views than in the old method of lines of force. Change lines into loops, and we can see some reason for a current to be set up in the wire around which these go, but can see none because "lines of force" pass through a space bounded in one direction by a conductor. Action and reaction are equal and opposite. The current sets up the loops. Why not the loops set up the current?

Considering these ideas in connection with dynamos, it is explained that the active part of the armature is to be found in the wire around which the magnetic loops pass.

HEAVY SWITCH, SAFETY JUNCTION, AND REGULATING GEAR.

A special branch of the electrical fitting trade has recently sprung up in the supply of heavy fittings, and the works on the Albert-embankment of the Electrical Engineering Corporation have been almost exclusively devoted to developments of such specialties for switch, safety junction, and regulating gear for electrical supply stations, electrical traction, isolated installations, transmission plant, etc. These, owing to the large currents and constant use, have to be thoroughly well designed and very solidly made. The sets of appliances for these different purposes have, by careful organisation, been standardised, and this enables an adequate stock to be kept ready for putting together for various requirements: this standardising of stock patterns is particularly useful when it is a question of prompt deliveries. The parts are kept in stock, finished and in the rough, for various currents of 20, 50, 100, 200 amperes, etc., so that any combination for particular purposes can be turned out with the greatest despatch.

The specialties to which reference has been made comprise main switchboards for electrical supply stations, by means of which any dynamo or dynamos can, together or separately, be switched on to any circuit. Some very large switchboards have been recently made, some of them weighing many hundred-weights, for large distributive centres. Regulators, for maintaining constant potential on the mains, are also in large demand, as well as for charging and discharging accumulators. High-tension safety junctions are any feature, both for use in conjunction with the main switchboard and on the primaries of the converters on the consumer's premises.

Owing to the growing number of house installations, a large demand is arising for house switches for disconnecting the consumer's house from the mains. These appliances have been specially adapted for distribution on the transformer system, and it is worthy of particular note that they are so constructed that it is not possible for anyone to touch the "current-carrying" parts except by deliberate intent. The Albert Works have now in hand switch gear of this character for a large supply station on the Continent, and for others in the United Kingdom.

With regard to traction work, it is particularly necessary that switch and regulating gear should be at once substantially made, simple, and reliable. The corporation have given a large amount of special attention to this class of work, and have not failed to benefit by the large experience which they have had in this branch of work. Reference has already been made in these columns to the switch and other gear which the corporation furnished for the Northfleet Tramways. They are now engaged on an extensive order for traction plant and accessories for tram lines in Rome and elsewhere.

The extent of the demand for high-class switch gear of this character, and the fact that it has been specialised in the manner described is as good an indication as any other of the enormous strides which are being made in the various branches of electrical engineering. Whereas, some three years ago, orders for the heavier accessories of the above character for electrical work were comparatively small, it is now no uncommon thing for the Albert Works to be engaged on equipments representing values ten times greater than then.

We may refer in passing to the special insulator fittings (Drummond's patent), of which the corporation are sole manufacturers. As is well known, the electrical engineer has frequently to deal with the galleries of mines and other situations, where the walls, etc., are reeking with damp and present a "woeful pageant" to encounter. The difficulties to encounter in such situations are altogether different from those in house lighting. These fittings are calculated to very much modify, if not entirely overcome, these difficulties. The main principle may be briefly described as a modification of a double-shed P.O. pattern insulator, arranged so that it can be combined with lamp switches, safety junctions, lampholders, and other necessary fittings. We shall have an opportunity of describing and illustrating these at a later date, but enough has been said to indicate their particular function.

The Alliance Engineering Works at West Drayton are now, of course, the principal ones of the Electrical Engineering Corporation, and are devoted to the manufacture of engines, dynamos, and the other heavier plant for the purposes for which the Albert Works manufacture accessories.

THE ETHER THEORY OF 1839.

The full title of a small pamphlet by Mr. J. Johnstone which lies before us is "The Ether Theory of 1839 is the True Theory of the Leyden Jar as Established by Modern Electrical Discoveries, part first". It seems that Mr. Johnstone contributed a letter to the *Greenock Advertiser* on December 27, 1839, and the publication of Dr. Lodge's book last year causes him to reprint this letter with some 28 pages of controversial matter. Probably, Dr. Lodge will not trouble himself to read the pamphlet, or if he reads it will not trouble to answer it. He will, and with justice, say that Mr. Johnstone has not understood his book, and does not understand the true theory of the Leyden jar. However much in advance of the time Mr. Johnstone was in 1839, the views he then expressed are not in accordance with the knowledge of 50 years after. Mr. Johnstone makes a number of statements which hardly accord with facts. Thus he says: "It has been long known that if a Leyden jar be suspended by silk threads, it is impossible to charge it whilst thus insulated." Now it is not only possible but an exceedingly simple matter to charge a Leyden jar so insulated. It may be that it cannot be charged by Mr. Johnstone's method which is hinted at in the following sentence: "The fact is that there is only one electric fluid, and that when the electrifying machine is put in motion for the purpose of giving electricity, *the rubber merely draws the electric fluid out of the ground, and the prime conductor gives it out.*" We have italicised the portion of the sentence referred to as not in accordance with existing views. We thought the idea of the earth being a vast reservoir was given up long ago, and that all the modern tendency was to explain the earth's action, if required at all, in charging a Leyden jar as merely forming a link in the circuit. Mr. Johnstone's antagonism to Dr. Lodge, or rather to Dr. Lodge's theories, seems principally founded upon this statement, that an insulated Leyden jar cannot be charged. For besides the words we have quoted, the statement is again made. On page 26 we have: "It is proverbial that an insulated Leyden jar cannot be charged; it is the act of insulation which prevents the current of electricity passing to earth, which would natively go there through the glass but for the insulation preventing it. This is the reason why the jar will not take the charge." Of course, the assumption here again is that the electricity is, as it were, pumped out from the earth into the jar, which, as we have said, is, according to modern ideas, a pure fallacy. We have no objection at all to acknowledge that the modern views all tend to the point that the ether plays an exceedingly prominent part in all electrical phenomena, even if it be not the cause of these phenomena. Thus far, then, the 1839 views of Mr. Johnstone may be accepted; in all other things we are inclined to think him wrong. What, for example, is the opinion of the ordinary electrician as to the statement that electricity passes through the pores of glass, and the assumption founded upon this that the particles of the electric fluid are less than those of air. That glass can be perforated and smashed up by means of electricity is no new thing, but the ordinary mind has always taken for granted that the glass of the Leyden jar was the insulating medium between the two coatings of foil through which the electricity could not pass, although sometimes the pressure generated is so intense as to break the glass.

DOUBLE-BREAK DOUBLE-POLE SWITCH.

The accompanying are illustrations of Mr. Arthur C. Cockburn's double-pole switch with double break in each circuit for high-tension circuits, alluded to in another column, a class of switch exceedingly useful for transformer work, originally introduced by him, and for which due credit should be given. The two poles are arranged so that they can be at any distance apart, and yet be controlled by one handle, together with spring locking mechanism, thus enabling both circuits to be either made or broken simultaneously.

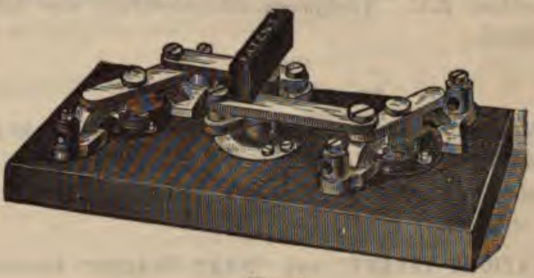

FIG. 1.

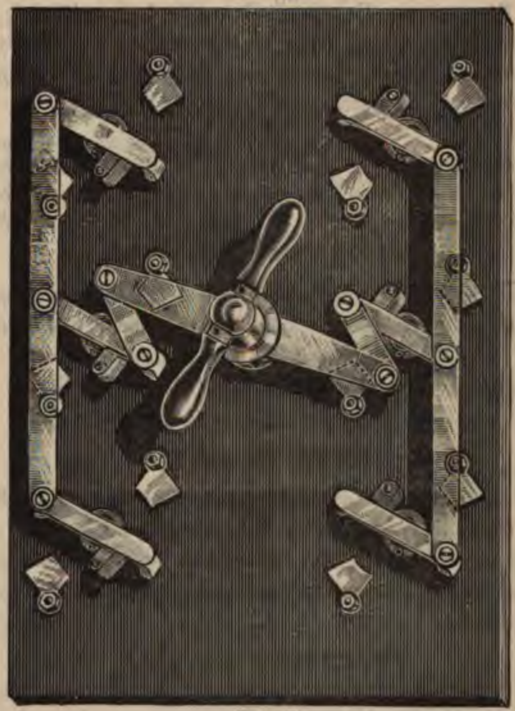

FIG. 2.

As is shown in the second cut, the same principle may be applied to break several circuits by a simple movement of the handle, each circuit being broken in the same manner both on positive and negative wire simultaneously.

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Specimen copies of the paper will be sent on request.

THE ELECTROMAGNET.

The text of this article should perhaps be Prof. S. Thompson's "Cantor Lectures on the Electromagnet," delivered under the auspices of the Society of Arts, in the theatre of this institution during the past three weeks. The concluding lecture of the series will be given next Monday. Both the society and the lecturer are to be congratulated upon these lectures. They are brimful of valuable information, and should be attentively read and studied when printed in the society's *Transactions*. It was Prof. Forbes who said, "I have been sometimes simply astounded to see the waste of labour, time, and money which have been lavished on determining the proper thickness of wire with which to wind a coil without overheating for a dynamo field-magnet," etc. Prof. Thompson has not said so in as many words, but he is evidently as astounded at the lack of intelligent interest and knowledge to be found about electromagnets. Prof. Forbes referred to heating, Prof. Thompson has dealt with the "tractive" and the "attractive" effects. He uses the term "tractive" action to denote the pull of a magnet upon its armature when the armature is in contact or very near the poles, and "attractive" action to that at a greater distance. The whole course of lectures has tended towards the simplification of the subject, but, as will be seen, we think simplification can go still further. The lecturer has been cynically hard, and justly so, upon South Kensington examination questions. The Science Department seems to progress backwards, and to have become an institution for the propagation of antediluvian information. Half-a-dozen publishers are periodically issuing books "specially adapted" for these examinations, the practical value of which, from the student's point of view of obtaining real information up to date, would be better obtained by viewing the volumes consume at the back of the fire rather than by reading them. If there is an Augean stable requiring a thorough clean out, it is to be found in the Science Department, South Kensington. What a really valuable institution it would be if a little common-sense ruled there, while as it is, sleepy-hollow is a lively and go-ahead place compared with it. Hit away! Prof. Thompson—hit hard, we have always found you "hit fair." We forget the exact subject that caused allusion to South Kensington, perhaps it was the declamation against the parrotism that iterates and reiterates and emphasises the truth of the "law of inverse squares" as applied to magnets. Was it that that law found an appropriate answer to a South Kensington examination question? If so, question, answer, and place are well connected. This law of 'inverse squares" applied to various electrical and magnetical questions has been traversed again and again. If we remember rightly, Sir W. Snow Harris had an utter contempt for it, in his particular hobby, but hitherto it has survived all onslaughts, and finds a place in almost every book upon the subject of electricity and magnetism that appears. Let us hope that Prof. Thompson's *exposé* has utterly killed it. There is another point to which the Professor's attention might be directed. Does he believe in repulsion? He still teaches that like poles repel and unlike attract, like currents repel and unlike currents attract. Has he given this part of the subject the attention he has given to the law of inverse squares?

Prof. Thompson commenced his lectures by promising to make the laws relating to electromagnets so clear and so simple that there would be no difficulty hereafter in designing and making an electromagnet that should be in accordance with specification. Electromagnets are utilised in mechanism for various purposes—some are required for a long pull, some for a short one, some for very rapid action, some when the action can be slower. Each different requirement means a different design, but the lecturer included all sorts and conditions, and it must be conceded that he has fairly kept his promise. The publication of this series of lectures should give the death blow to the vague generalities that maintain their hold upon the majority of electricians, and effectively dispose of the idea that there is something uncanny with regard to such magnets that will not lend itself to exact computation. We have been careful all along to write electromagnet, for we do not suppose Prof. Thompson or anyone else will be bold enough to include permanent magnets within the category of performing exactly what they were designed to do.

We had hoped that Prof. Thompson would have looked more favourably upon the unit suggested by Mr. Kapp, because Mr. Kapp is an engineer, which, with all due deference to Prof. Thompson, he is not. Mr. Kapp measures revolutions in minutes. Prof. Thompson would probably measure in minutes or half minutes as the case might be, divided by 60 or by 30, and work with revolutions per second. Units involving methods usually followed by engineers will be far more quickly and easily adopted than units involving methods which they do not and cannot directly follow. The learned lecturer has shown his large-mindedness in many ways, and that he is trammelled by no consideration of pedagogic conservatism. Let him then try and put himself in the place of the ordinary, not the extraordinary, engineer, and approximate his ways and his methods of work and calculation to those ordinarily ruling in the shops. Ninety-nine Englishmen out of a hundred, who really are mechanical engineers and not schoolboys, will prefer inches, square inches, and revolutions per minute, to centimetres, square centimetres, and revolutions per second. The men who know this, and give calculations and units accordingly, are hardly to be condemned as marring good work by "mixed units." If those who write books would only think a little more of those who make machines, it would usually save the time required to translate the language of the theorist into the language of the practical man.

CORRESPONDENCE.

NEW DOUBLE-BREAK SWITCH.

To the Editor of The Electrical Engineer.

Sir,—Noticing in your issue of last week that you describe and illustrate a double-break switch by Messrs. Woodhouse and Rawson as *new*, I would draw your attention to those made by my firm and patented in December, 1888. These switches were shown at the Building Trades Exhibition in August last, and again at Bingley Hall, Birmingham, and illustrated in the Exhibition number of *Electrical Plant*. It has also been illustrated in one of my firm's switch catalogues during the whole of last year.

I have pleasure in sending you blocks of simple double-pole switches, also one illustrating a six-way switch, working on the same principle.—Yours, etc.,

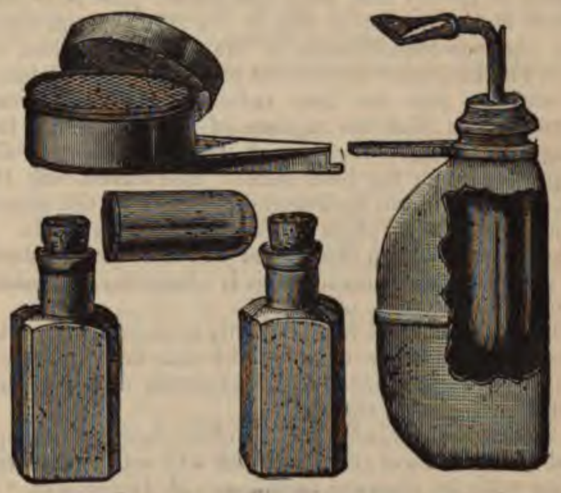
Arthur C. Cockburn.

Acme Electric Works, London, N.W., Feb. 5, 1890.

A NEW FLASH-LAMP FOR PHOTOGRAPHY.

To those of our readers who have experienced difficulties in photographing machinery under unfavourable conditions of light we would suggest a trial of the Hibbard "repeating flash-lamp," an American invention, of which Messrs. Fry and Co., the well-known platemakers of Chandos-street and Kingston-on-Thames, are the wholesale agents.

Besides the ingenious arrangement for repeating the flash from one charge of magnesium powder, it possesses several novel features which will be sure to recommend it to the photographer.



The powder is propelled through the flame by compressing the body of the lamp itself, which is made of thick rubber. Hence, only one hand is required for its manipulation, and it is possible to use two of these lamps simultaneously at points 4ft. or 5ft. apart. We strongly advise this plan in the case of portrait and group work, as the strong shadows are thereby destroyed, and any involuntary movement of the subject will not show in the resulting negative.

Where there is no danger of movement, as in photographing machinery or interiors, one lamp is all that is required, this being moved to different points and the flash repeated several times.

We have tested this apparatus on an interior and find that two flashes only are required to give a fully-exposed negative, using a rapid plate and Perken and Rayment's new "wide angle Euryscope lens" stopped to $\frac{f}{11}$.

The illustration will show the various parts of this ingenious lamp, the whole of which can be packed in a box measuring 5in. × 3½in. × 2in.

THE CHEMICAL THEORY OF ACCUMULATORS.*

The true chemical theory of the accumulator is one which will have given the greatest trouble to establish, and will have furnished the most diverse interpretations, resulting, in great part, from the difficulty of carrying out the analyses which all chemical theory necessitates, and the tendency to enunciate formulas from analogies or from mere personal intuition. Some of the theories promulgated nevertheless appear to draw very near to the truth, if not entirely, at least within a few degrees. Such, for example, is the theory enounced by M. St. Drzewiecki last month at the Société Internationale des Electriciens.

Since the International Congress of Electricians, M. Drzewiecki has been led for sundry reasons to modify the theory which he then brought forward. The author shows first that the hypothesis of peroxide of lead (PbO_2) on the one part, and of *metallic* lead on the other part, is inadmissible, since if these elements are taken the measured electromotive force is considerably less than that of the accumulator. As to the theory based upon thermo-chemistry and the formation of sulphate of lead ($PbSO_4$) at the two electrodes, this must be equally rejected, and the agreement of the E.M.F.'s given by theory and by experiment can only be regarded as a simple coincidence. The author then attacks the theory of double sulphating, arguing that the plates after discharge are not white, which should be the fact if a double sulphate of lead were formed. But nowadays, in the theory of double sulphating, it is admitted that acid or basic sulphates are formed and not the sulphate ($PbSO_4$), which alone is white. M. Drzewiecki continues in these terms: "A most conclusive argument is based upon the following experiment: if two plates are made of compressed sulphate of lead, and these are submitted for several days to the action of a current in acidulated water, it will be seen that the negative plate is completely reduced to spongy lead, while the *positive plate never passes from the state of sulphate to that of binoxide.* In this experiment the non-conductibility of the sulphate of lead cannot be invoked, since the current passes and the sulphate of the negative pole has been reduced." We will simply answer to this that the sulphate of lead is a highly insulating body, and it acts as though it were a coating of silica compressed upon the lead plates. The current can then pass, and the nascent hydrogen disengaged on the negative plate reduces the sulphate of lead by simple presence. As to the nascent oxygen disengaged at the other pole during the passage of the current, this is altogether incapable of oxidising the sulphate of lead.

This argument, which applies only to the sulphate of lead ($PbSO_4$), is therefore destroyed by this fact, and has no influence upon the theory of the formation of two different sulphates of lead on the plates.

"As to the enunciation of a complete theory and the proposal of a formula of reaction which will not be in contradiction with the observed facts," says M. Drzewiecki, "the problem appears most complicated and difficult. Direct analyses of the plates are, if not impossible, at least extremely delicate, because of the liquid which remains imbibed in the spongy mass, and of the spontaneous modifications which may be produced on the mass of the electrodes themselves when taken from the bath and exposed to the air. For the same reasons the weighings of plates become very difficult, while these, if made in the liquid itself, would serve as no basis for reasoning on account of the variations of volume of the plates, and of the small gas bubbles enclosed within the spongy mass.

" . . . The hypothesis which, until proof to the contrary is obtained, would seem to conform the best to the results of experiment, is the following:

"The positive plate of an accumulator *formed*, but *not yet charged*, should consist of an oxide of lead superior to PbO_2: it would have for formula Pb_2O_5; this would be a plumbic anhydride . . . The charging current would produce at the positive pole binoxide of hydrogen (H_2O_2), which, uniting with the plumbic acid, would form a composition ($H_2Pb_2O_7$) which might be called perplumbic acid *(acide perplombique)*, by analogy with the persulphuric acid of Berthelot, which is generated under analogous circumstances.

"The formation of H_2O_2 at the expense of the electrolyte would liberate at the negative pole H_2, which would unite with the spongy lead of the negative plate, either under the form of the hydrate (H_2Pb_2), or under the form of occlusion."

"The charged accumulator would therefore be presented under the following form:

$$H_2Pb_2O_7 \mid 3\,(H_2SO_4) \mid Pb_2H_2.$$

" . . . The accumulator when discharged would consist of peroxide of lead at the positive pole, and at the negative pole in a mixture, or perhaps even a combination of hyposulphate of lead and of sulphate of lead."

$$Pb_2O_4 \mid H_2O \; \frac{4\,(H_2O)}{2} \left| \begin{matrix} S_2O_6Pb \\ SO_4Pb \end{matrix} \right. .$$

It seems to us hardly probable that there remains any of the peroxide of lead at the positive pole at the end of the discharge, for this oxide is easily reducible by the hydrogen, which is carried to this pole. On the other hand, the hyposulphate of lead is soluble in water and decomposable by acids with the disengagement of sulphurous acid; it is there highly probable that some of it is formed at this pole. As to the combination of sulphate of lead and hyposulphate of lead, it is as yet unknown.

To confirm this theory, M. Drzewiecki relies upon the thermo-chemical data, but the slight confidence which can be given to these values is known from the experiments of MM. Chroustchoff and Sitnikoff. Next, taking the reactions above indicated as a basis, M. Drzewiecki finds an increase of weight of 2·376 grams per ampere-hour for the negative and a diminution of 0·635 gram for the positive, giving a total of 1·738 grams increase at the discharge. "Now, comparing this figure with the figure found by the Antwerp Commission, a perfect agreement is arrived at; an average of 20 weighings gave at Antwerp for 36·5 ampere-hours a diminution in weight of 64·16 grams, whereas our calculation gives 63·443 grams."

We reserve all comment (says *L'Electricien*) on the figures found by the Antwerp Commission, the plates having been weighed within the liquid. We will return to them later on more in detail. But we would nevertheless remark that at the commencement of his paper, M. Drzewiecki has repudiated the theories based upon the weights of plates taken within the liquid.

To sum up, the theory of accumulators is not yet discovered, and if we have analysed and discussed the paper somewhat at length it is in the hope of giving rise to discussion which may throw a little further light upon this subject.

THE MAGNETIC NEEDLE IN THE DARK AGES.

From time to time paragraphs are going round the papers referring to the "magnet" and "telegraphy" in the dim and distant past. Some years ago we pointed out that this idea was pretty completely thrashed out in the *Transactions* of the Manchester Philosophical Society for 1876, but as technical journals and other papers are again mentioning the subject as some wonderful new discovery by archæologists, we give herewith two papers from the above-named *Transactions*, which say pretty well all there is to say in the matter.

"Note on a Curious Allusion of a Writer of the 17th Century to a supposed Property of the Magnetic Needle, since verified in the Invention of Telegraphy," by HARRY GRIMSHAW, F.C.S.

Some little time ago my friend, the Rev. G. W. Reynolds, M.A., of Cheetham Hill, directed my attention to a paragraph in an old volume in his possession of some 250 years of age, which struck me as a peculiarly interesting one; so much so, in fact, that I have taken the liberty of bringing it before the notice of this Society.

---

* Translated from *L'Electricien* of Jan. 25, 1890.

The work in question is entitled, "An Apologie of the Power and Providence of God in the Government of the World, or An Examination and Censure of the Common Error touching Nature's perpetual and Universal Decay, Divided into Four Books." The author is one "G. H.," D.D. (Doctor of Divinity), and the work is printed at Oxford by John Litchfield and William Turner, "Printers to the famous University." Anno Domini 1627, being therefore exactly 250 years old.

The third book of the four into which the work is divided treats of "The pretended decay of mankind in regard and duration, of strength and stature, of arts and wits." The tenth chapter of this third book is said to be "Touching diverse artificiall workes and usefull inventions, at leastwise matchable with those of the ancients, namely and chiefly the invention of Printing, Gunnes, and the Sea-Card or Mariners Compasse." This tenth chapter again, for such is the orderly division of the subjects, is sub-divided into four sections, and the fourth of these is headed "Of the use and invention of the Mariners Compasse or sea-card, as also of another excellent invention sayd to be lately found out upon the Load-stone, together with the conclusion of this comparison touching Arts and Wits, with a saying of Bodius, and another very notable one of Lactantius."

It is in the account of this "excellent invention sayd to be lately found out upon the loadstone" that the curious prevision or dream, so to speak, of the application of electricity as a means of communication occurs, and there is small wonder that the old philosopher called it as he does further on, "an excellent and secret conclusion upon the stone," for, whilst perusing his description, one can hardly imagine that the writer has not in his mind's eye one of our most modern telegraphic instruments. I quote the paragraph in its entirety:

"Another excellent and secret conclusion upon this stone, pretended to be found out in these latter times, is that by touching two needles with the same stone, they being severally set so as they may turne upon two round tables, having on their borders, the *Alphabet* within circlewise, if two friends agreeing upon the time, the one in Paris, the other in London (having each of them their table thus equally fitted) be disposed upon certayne dayes and at certaine houres to conferre, it is to bee done by turning the needle in one of the tables to the *Alphabet*, and the other, by *Sympathie* will turn itself in the same manner in the other table though never so farre distant: which conclusion if infallibly true, may likewise proove of good and great consequence; howsoever I will set it down as I find it described by *Famianus Strada* in imitation of the stile and vaine of *Lucretius*."

Magnesi genus est lapidis mirabile, &c., &c.

Then follows the extract in Latin, with the English translation in verse attached.

It will be acknowledged by anyone familiar with the instrument, that the dial telegraph of Cooke and Wheatstone, invented subsequently to their first upright needle form, most curiously carries out the ideal description of this old author, and it will be seen that the date at which his work is written was nearly 200 years prior to the first attempt made to communicate at a distance by means of magnetic needles.

The following dates may be incidentally mentioned on this point. First, in 1733, Du Fay succeeded in transmitting the electricity from an excited glass tube to the distance of 1,256 feet along a wet packthread. Then in 1748 Franklin set fire to spirits of wine by means of a current of electricity passed through the water of the Shuylkill river. Neither of these experiments were, however, undertaken with any idea of transmitting signals, the first attempts of this kind being perhaps those of Lesage and of Lomond, in 1774 and 1787 respectively, who used the divergence of pith balls to indicate letters. These are all of course experiments with statical electricity, and we have to come down to Volta with his discovery of the Voltaic Pile in 1800 for the means of applying dynamical electricity for the purpose in question. Then through Oersted's discovery of the action of electrical currents on the magnetic needle, in 1819, and Ampère's suggestion, in 1820, that this action should be used in signalling, we come to Cooke and Wheatstone's first patent for a telegraphic instrument in 1837; bringing us through a journey of just about 200 years in order to arrive at our practical realisation of this vision of the old writer.

"Note on a Passage in Strada containing a Prevision of the Electric Telegraph," by WILLIAM E. A. AXON, M.R.S.L., F.S.S.

The interesting quotation from Hakewill's Apology brought by Mr. Grimshaw before the last meeting of this Society, seems to need an additional word of comment. Hakewill, it will be remembered, quotes a passage of Latin verse from Strada in which he supposes the loadstone to have such virtue that "if two needles be touched with it, and then balanced on separate pivots, and the one be turned in a particular direction, the other will sympathetically move parallel to it. He then directs each of these needles to be poised and mounted on a dial having the letters of the alphabet arranged round it. Accordingly, if one person has one of the dials and another the other, by a little prearrangement as to details, a correspondence can be maintained between them at any distance by simply pointing the needles to the letters of the required words." The date of the first edition of Hakewill's Apologie or Declaration of the Power and Providence of God in the Government of the World is 1627; but the work of Strada's from which he quotes was published ten years earlier. Famianus Strada was born at Rome in 1572, and his Prolusiones Academeciæ et Paradigmata Eloquentiæ appeared at Rome in 1617. Several editions of his Prolusiones have been printed in this country. The particular poem referring to the loadstone has been translated into English and is printed in "The Student or Oxford and Cambridge Miscellany," 1750. The passage is referred to by Addison in a paper in the *Spectator*, No. 241, and in the *Guardian*, No. 119. In the former of these he adds: "In the meanwhile, if ever this invention should be revived or put in practice, I would propose that upon the lover's dial plate there should be written not only the four-and-twenty letters, but several entire words which have always a place in passionate epistles: as flames; darts; die; language; absence; Cupid; heart; eyes; hang; drown; and the like. This would very much abridge the Lover's pains in this way of writing a letter, as it would enable him to express the most useful and significant words with a single touch of the needle."

Akenside, in speaking of the laws of association and sympathy, says:

> For when the different images of things,
> By chance combined, have struck the attentive soul
> With deeper impulse, or connected long,
> Have drawn her frequent eye; howe'er distinct
> Th' external scenes, yet oft the ideas gain
> From that conjunction an eternal tie
> And sympathy unbroken. Let the mind
> Recall one partner of the various league,
> Immediate, lo! the firm confederates rise,
> And each his former station straight resumes:
> One movement governs the consenting throng,
> And all at once with rosy pleasure shine,
> Or all are saddened with the glooms of care.
> 'Twas thus, if ancient fame the truth unfold,
> Two faithful needles, from the informing touch
> Of the same parent-stone, together drew
> Its mystic virtue, and at first conspir'd,
> With fatal impulse quivering to the pole;
> Then, though disjoin'd by kingdoms, though the main
> Roll'd its broad surge betwixt, and different stars
> Beheld their wakeful motions, yet preserv'd
> The former friendship, and remembered still
> The alliance of their birth; whate'er the line
> Which one possessed, nor pause nor quiet knew
> The sure associate, ere with trembling speed
> He found its path and fixed unerring there.
>
> (*Pleasures of the Imagination*, Book iii.)

This passage is cited in Dr. Thomas Brown's Philosophy of the Human Mind (16th ed., 1846, ii. 220).

Strada's fancy is also referred to in the Abridgements of Specifications relating to Electricity and Magnetism (1859, p. xliii.), *Saturday Review*, August 21, 1858, p. 190; Moigno: Traité de Télégraphie Electrique, p. 58-59, and in

Keddie's Literary and Scientific Anecdotes, where several of the above references are to be found.

It is to be noticed that the effect is ascribed to the power of sympathy. This was an important doctrine of the time, and reached transcendental heights in the hands of Sir Kenelm Digby.

CONSTANT E.M.F. WITH VARIABLE SPEED.

BY PAUL HOHO.

In studying the problem of obtaining constant E.M.F. in dynamos driven at variable speeds, the writer has devised a number of arrangements by which this can be effected electrically without the intervention of wasteful resistances.

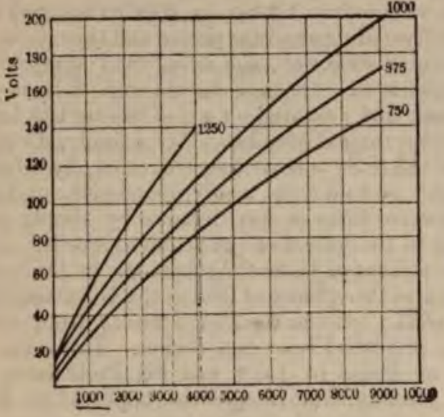


FIG 1.

Suppose we wish to obtain a dynamo machine having a constant E.M.F. equal to 100 volts, and with a speed varying from 750 to 1,250 revolutions per minute, then Fig. 1 represents the characteristics for a machine for speeds comprised between 750 and 1,250 revolutions. We take from the characteristics the values of the ampere-turns necessary for these different speeds in order to produce 100 volts, and, plotting these values as ordinates, we obtain in the curve *a*, *b*, *g*, Fig. 2, a reduction of the ampere-turns necessary to obtain 100 volts at the speeds of between 750 and 1,250 revolutions. It will suffice then to provide for the dynamo an excitation variable with the speed, according to the law determined by the curve *a*, *b*, *g*, Fig. 2. The writer's system permits of obtaining this excitation in different ways; among others, by means of two small auxiliary machines, which case we will now examine.

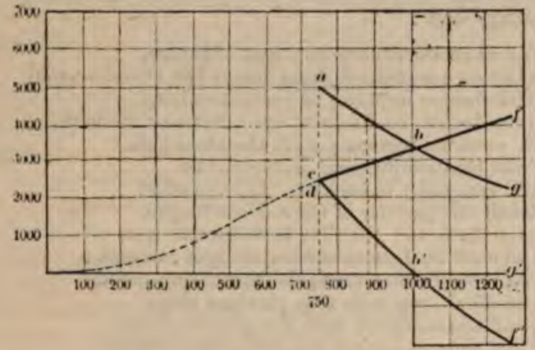


FIG. 2.

In order to more clearly understand the system we will suppose that the behaviour of these two machines is known in advance and represented respectively by the curve I and by the curve II of Fig. 3. These curves then give the number of volts produced respectively by the auxiliary machine revolving individually as a function of the speeds. By means of these two auxiliary machines we can excite the magnets of the machine in several ways, among which is the following: A primary exciting circuit is wound on the magnets of the main machine and fed by the auxiliary machine I. The second exciting circuit is fed by a current resulting from the difference of the E.M.F.'s produced by the two auxiliary machines; *i.e.*, that this, the second, circuit is put in series with the armatures of the two auxiliary machines, the two like poles of which correspond. As shown in Fig. 3, the two auxiliary machines have at 1,000 revolutions a difference of E.M.F. equal to zero. Thus at 1,000 revolutions the second circuit is fed by a current equal to zero, and the total excitation at 1,000 revolutions ought to be furnished by machine I only, in the primary exciting circuit. That is, the first circuit ought to be calculated in such a manner that the E.M.F., $q\,m$, produced by machine I at 1,000 revolutions causes an excitation represented by $b\,b'$, Fig. 2. It is these factors which determine the constant of the primary exciting circuit. For the other speeds the excitation produced by the first circuit will be proportional to the E.M.F. which supplies that circuit—that is, to the E.M.F.'s represented by the curve I, Fig. 3.

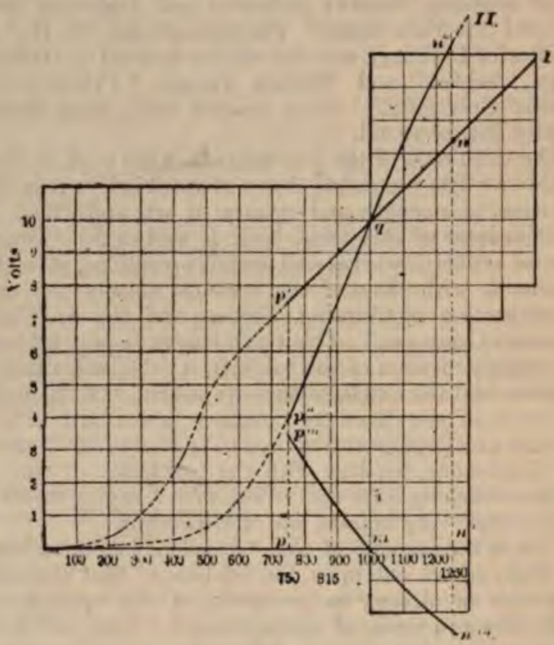


FIG. 3.

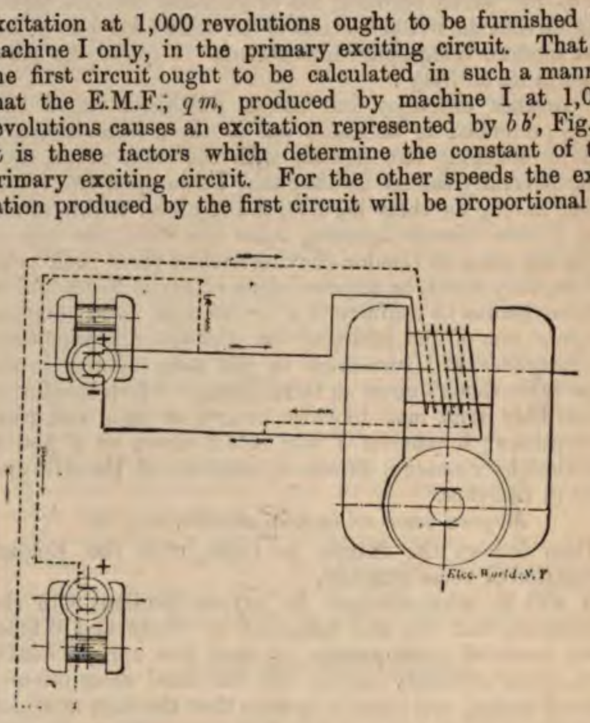


FIG. 4.

It suffices then to furnish an excitation represented by the algebraic difference of the ordinates of the curves *a*, *b*, *g* and *c*, *b*, *f*, Fig. 2, which differences are represented by the ordinates, at first positive, then negative, of the curves *d*, *b'*, *f'*, Fig. 2. As has been said, these excitations ought to be furnished in the second circuit by the differences of the E.M.F. of the two auxiliary machines. At 750 revolutions there is a difference of E.M.F. equal to $p'\,p''$, Fig. 3.

The latter ought to produce an excitation equal to $d\,d'$, Fig. 2, which allows of the calculation of the constants of the second exciting circuit. Thus the excitation required is obtained for 1,000 or 750 revolutions. This required excitation could also be obtained for any two speeds whatever be the characters of the machines I and II, and provided that their characters are different.

There remain still the other speeds; for these the excitations to be produced in the second circuit are given by the ordinates of the curve d, b', f', Fig 2. If $p' p''$, in Fig. 3, gives an excitation equal to $d d'$, Fig. 2, the curve p''', m, n''', Fig. 3, in which $p''' p$ equals $p' p''$, and the ordinates of which are proportional to the ordinates d, b', f', Fig. 2, represents the E.M.F.'s which ought to be supplied to the second exciting circuit in order to obtain the proper excitation for all the speeds comprised between 750 and 1,250 revolutions. If from the ordinates of the curve I, Fig. 3, we subtract algebraically the ordinates of the curve p''', m, n'', we obtain the curve p'', q, n'', which represents the character which the auxiliary machine II ought to possess, in order that, upon the combination which we have explained, we may obtain a proper excitation for all speeds comprised between the limits given. In this example the curve p'', m, n'' corresponds exactly to that of the machine II, because that machine, as well as machine I, taken in advance, were chosen alike. The more the real curve of machine II represents exactly what we have just indicated, the more perfect will be the regularity between 750 and 1,250 revolutions. It is necessary to remark that the regulating influence will already be effected before 750 revolutions are reached, and will continue even after 1,250 revolutions are passed, and that to a degree which will depend on the nature of the auxiliary machines.

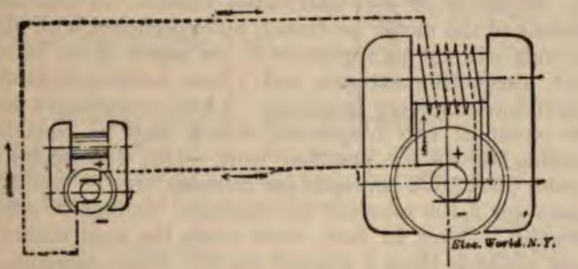


FIG. 5.

The characteristics from which we have started out in the present example affect the form which Prof. Kohlrausch determined for a dynamo in 1887. The two curves of the E.M.F.'s, I, II, in Fig. 3, correspond to the machine, the characteristics of which take the same form as that shown in Fig. 1.

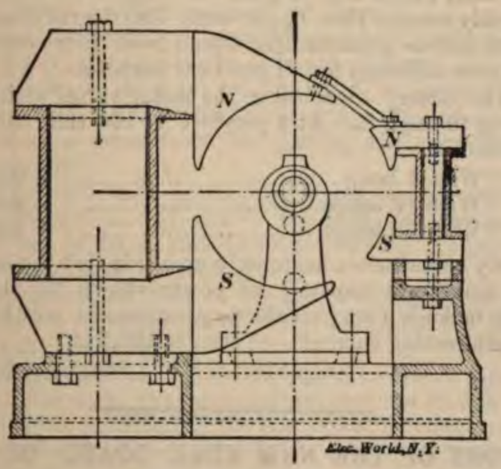


FIG. 6.

Now, in order to govern the two auxiliary machines, it is necessary to observe, in addition, the nature and construction of the individual machines and the arrangement of new elements. Thus, these two machines may each be excited by themselves and by the other, or by both. The latter, however, would complicate the problem uselessly. In the example which we have described, we arrive at the same results in operating separately the two auxiliary machines on two distinct circuits arranged in such a way as to produce an inverse excitation; that is, a differential arrangement, as shown in Fig. 4.

In the example which we have described we have had recourse to two auxiliary machines for the excitation. If, in order to produce excitation, we employ the E.M.F. produced by the main machine, it is only necessary to take a single auxiliary machine. In that case the calculations are analogous to those already given. It is only necessary to take account in the combination and in the calculations of the fact that this source of excitation is itself subject to the regulating effect. This arrangement is shown in Fig. 5.

It is possible, however, to arrive at the same result without having recourse to auxiliary machines. In that case the exciting currents are taken from different points of the commutator. It suffices that brushes in contact with the latter span those portions of the armature in which the magnetic field varies differently when the speed varies. To that end we are naturally led to subject the armature to the action of different magnets and pole-pieces. Among these combinations which may be varied infinitely, we will only mention the following: Let us imagine a machine, the armature of which receives its magnetism from two pole-pieces, each of which forms a consequent pole. If that pole-piece, instead of being constructed as one piece, be composed of two separate pieces, Fig. 6, so arranged that one is more saturated than the other, magnetically, the magnetic intensity which they will effect respectively in the corresponding portion of the armature will vary in these proportions by reason of the two different functions of the speed. It suffices, therefore, merely to take two exciting currents by means of three brushes placed on the commutators on corresponding points at the ends of the pole-pieces. The result is that, with these combinations, these points constitute the neutral points from which the proper current can be taken.—*Electrical World* (New York).

REPORT ON THE ARON METER.

Subjoined we reproduce the results of careful and exhaustive tests made by Mr. Gisbert Kapp on a meter of Dr. Aron. It is the first report of importance that has been published thereon, and we commend it to the attention of our readers. The construction of this apparatus is too well known to require description, suffice it to say that several thousands of these meters are now used all over Europe, and appear to give great satisfaction. It will be seen that the instrument in the hands of Mr. Kapp worked with remarkable precision, both with continuous and alternating currents, the maximum error in the one case being below ½ per cent., and in the other less than 1¼ per cent., the tests extending over the whole range of the instrument. Such results fully deserve being put on record.

"31, Parliament-street, Westminster, S.W.,
"January 27, 1890.

"Messrs. The General Electric Company, Limited,
71, Queen Victoria-street, E.C.

"Gentlemen,—I have subjected the Aron meter which you supplied to a series of tests extending over about 10 days, and now report to you on the results of these tests.

"The meter consists of a pair of pendulum clocks so geared together as to register the difference in their rates on a set of dials. One of the clocks has an ordinary pendulum, whilst the bob of the pendulum of the other clock consists of a fine wire solenoid, placed horizontally and swinging within a fixed solenoid of much stouter wire, through which passes the supply current which is to be metered. The fine wire solenoid is connected in series with a resistance coil, and the two form a shunt to the supply leads. The connections are so arranged that there is attraction between the shunt solenoid and the main solenoid, and consequently acceleration of the electric as compared with the gravity pendulum; the difference in rate, which is registered on the dials, being very nearly proportional to the amount of energy passed through the meter in any time. To find this energy we have, therefore, to multiply the numbers registered on the dials by a coefficient which must be determined for each meter by experiment, and which in absolutely perfect meters should be a constant for all currents and pressures within the range of this instrument. I do not know any meter in which this coefficient is absolutely constant; it varies with the amount of current, and the amount of variation is an indication of the greater or lesser accuracy of the meter. To judge of the merits of a meter, it is, therefore, only necessary to determine the coefficient for different currents and pressures and to compare the coefficients with each other. The more nearly the coefficients, the greater is the degree of accuracy attained by the meter.

"I have tested your Aron meter at pressures varying between 130 and 95 volts, and with currents varying between 26 and seven amperes, both direct and alternating. In addition, I have also made a prolonged test with a direct current of 0·65 amperes.

"The meter is designed for a mean pressure of 100 volts and a maximum current of 25 amperes. I found that the coefficient is practically unaffected by variations in pressure between the limits of 95 and 130 volts. The pressure was measured by a Cardew voltmeter and by a Sir William Thomson electrostatic voltmeter. I calibrated the Cardew voltmeter by means of a Clark standard cell, and its indications agreed perfectly with Sir William Thomson's instruments. The currents between 26 and seven amperes were measured by a Sir William Thomson ampere balance, and the current 0·65 amperes was measured by a Sir William Thomson deciampere balance. With the larger currents the readings were taken every quarter of an hour, and with the smaller currents they were taken at longer intervals. In this case the current was taken through a single lamp from a secondary battery ordinarily supplying 40 lamps, and was therefore absolutely constant over a period of many hours, rendering it unnecessary to take frequent readings. The tests at high voltage (from 110 to 130 volts) were made whilst charging the secondary battery, and those at normal voltage (from 95 to 105 volts) were made whilst supplying the lamps from the battery when the current was direct, and whilst supplying the lamps from a transformer when the current was alternating. The conditions of the tests were, therefore, those which obtain in the actual use of meters.

The coefficient given by Dr. Aron for this meter is 1·07—that is to say, at about 100 volts pressure between the mains, one division on the uppermost dial represents 107 watt-hours. I first tested the meter in exactly the condition in which it came to me, and found that for currents varying between 25 and 15 amperes the coefficient given by the maker was nearly correct. For smaller currents the coefficient was, however, incorrect, and the error increased as the current was diminished. Thus, with current required for one single lamp, my test gave a coefficient of only 0·97. I found that this discrepancy was due to the fact that the meter had not been properly regulated before it was sent to me. In order that a clock meter of this kind may register accurately, it is necessary that the gravity pendulum should have exactly the same period as the electric pendulum when no current is passing. In this meter the gravity pendulum had a longer period, and, consequently, the meter registered even when no current was passing. This defect can very easily be rectified, since the gravity pendulum is provided with a weight which can be screwed up or down, as may be required, in order to bring the two pendulums to absolute synchronism. I found it very easy to make this regulation, and my subsequent tests were made with the meter so regulated. I mention this matter, to draw your attention to the necessity of regulating every meter after it is installed.

"*Test of Meter with Direct Currents.*

"The meter being intended for a 40-light installation, it seemed advisable to test it within the limits of current which would ordinarily obtain in such an installation; I made, therefore, prolonged tests with currents of 8 and 23 amperes, which corresponded to 12 and 35 lamps respectively. The coefficients I obtained were the following: with 35 lamps 1·130, with 12 lamps 1·141. I also made a prolonged test with a single lamp, in order to determine the accuracy of the meter at the lowest current at which it can possibly be used in practice. This test is for all meters the most severe, since any error, however small absolutely, becomes relatively large if the current to be metered is itself very small. I found that even at the lowest limit of current the Aron meter gave a remarkably accurate result, the coefficient being with one lamp 1·146.

"On the basis of these figures it is now possible to form an estimate of the accuracy of the meter when in practical use. Taking the mean between the coefficients for 12 and 35 lamps, I find 1·1355 as the coefficient to be used with this meter. The maximum error which would obtain if the meter were always worked at the lower or always at the higher limit of current would then be half per cent., but as in practice the meter will generally be worked at intermediate the probable error will be less than half per cent. I need hardly say that this degree of accuracy is greater than that of any gas meter, and more than sufficient for all practical purposes.

"*Test of Meter with Alternating Currents.*

"As there must necessarily be some self-induction in the fine wire coil forming the bob of the electric pendulum, the shunt current must lag behind the main current and the acceleration will be somewhat less than with a direct current representing the same energy. It will also be evident that the difference will be the greater the higher the frequency of the alternating current, so that the coefficient of the meter as found by experiment with direct currents will not be applicable if the meter is to be used with alternating currents and a new coefficient must be determined for every frequency. I have accordingly tested the meter at two frequences, which may be considered limiting values for practical work—viz., 105 cycles per second (or 12,600 reversals per minute), and 70 cycles per second (or 8,400 reversals per minute). As regards current strength, I have in both cases made the tests within the same limits as those I adopted for the direct currents, and I give the results in the following table:

Number of lamps supplied.	Coefficient for a frequency ot	
	105.	70.
35	1·195	1·170
12	1·220	1·194

Taking as before the averages between these figures, I find that the coefficient to be used with this meter is

1·217 for a frequency of 105, and
1·182 for a frequency of 70.

"In either case the maximum possible error is about $1\frac{1}{4}$ per cent., whilst the probable average error will be considerably smaller than $1\frac{1}{4}$ per cent. This degree of accuracy, though not so great as that found with direct currents, is still quite sufficient for all practical purposes.

"The energy absorbed in the meter varies with current passing through it. At a pressure of 100 volts the energy absorbed is

"With 1 lamp	3 watts.
"With 12 lamps	4 watts.
"With 35 lamps	9 watts.

"My experiments lead me to conclude that the accuracy, long range, and economy of power shown by the Aron meter make it a very satisfactory instrument both for direct and alternating currents.—Yours, faithfully,

(Signed) "GISBERT KAPP."

REPORT OF THE NEW YORK BOARD OF ELECTRICAL CONTROL.

The third report of the Board of Electrical Control of this city has been submitted to the Governor and Legislature, containing the record of the work accomplished by the Board during the past year.

After reciting the history of the Board and its work up to January 1, 1889, the report continues:

The Work of the Board.

The following table shows the construction of subways to date:

Service.	Miles Trench.	Miles Duct.
Telephone and telegraph	28	503
Electric light	29	454
Edison	16	50
Subsidiaries		10
Total	73	1,017

This construction will accommodate approximately 45,000 miles of telephone and telegraph wires and 2,000 miles of electric light wires.

The Removal of Poles and Wires.

On all the streets and avenues the companies whose wires have been provided for have been directed to remove their poles and wires from the surface within 90 days, and at the expiration of that time, in case they are not so removed, it becomes possible and proper for the local authorities to remove them forthwith.

As has been stated, no removals were made under this provision of the Act up to a very recent date, by reason of the apathy of the local authorities and the lack of co-operation on the part of the chief executive officer of this city until the beginning of the year 1889, and subsequent to that, owing to the injunctions procured by certain of the electrical companies.

The following table shows the poles and wires which have been removed as the result of work of the Board, either by the companies or by the Bureau of Incumbrances of the Department of Public Works.

	No. of poles.	Miles wire.
By companies	1,765	2,788
By Department of Public Works	3,007	2,827
Total	4,772	5,615

Subways and Underground Conductors.

The following table shows the number of miles of electrical conductors now in the subways, and the companies by which they are owned or operated :

Name of company.	Number of miles of underground wire.
Metropolitan Telephone	10,906
Western Union	578
Postal Telegraph	35
United States Illuminating	88
Brush Electric Light	38
Manhattan Electric Light	67
Harlem Electric Light	10
Mt. Morris	2
Edison	252
New York Fire Department	332
Total	12,308 miles.

In addition to this underground wire, some 2,000 miles of telegraph wire are being operated in cables on the elevated railroads under permits of the Board.

The principles which have been followed in inaugurating the underground system may be defined as follows :

1. A conduit or subway for electrical conductors is nothing more than a mechanical protection for the wires within it, and a convenience for placing and protecting them underground.
2. Electric light and power conductors should, as a matter of precaution and not of necessity, be operated separately, and as far as possible from those for the transmission of currents of lesser intensity.
3. The material and form of the subway should depend largely upon the requirements of the locality and the service for which it is designed.
4. Drawing-in-and-out conduits with convenient manholes are, in the main, the most desirable for the streets of this city, where a condition of the law allowing companies 90 days to place their conductors in the subways after they are constructed, necessitates that the subways shall be easily accessible without serious disturbance of the pavement.
5. The success of the underground service depends largely upon the proper insulation of the wires, and the largest liberty compatible with the preservation of the rights of others should be allowed to the companies making use of the subways.
6. The nature of local connections depends to a great extent upon the service and locality for which they are designed, and here, again, the liberty of choice under proper restrictions may reasonably be allowed.

Proceeding from these general principles, the Board has constructed subways in different localities largely differing in design, size, and material ; and time and experience only serve to strengthen the Board in its convictions and confirm its conclusions as correct.

In order that the statements contained above as to the sufficiency of the subways already constructed under the direction of the Board of Electrical Control may be substantiated by sworn testimony of those competent to judge of matters of this kind, affidavits are appended sworn to by Mr. J. P. Barrett, the city electrician of Chicago ; Mr. J. Elliott Smith, the superintendent of the New York City fire department telegraphs ; Mr. Sunny, president of the Consolidated Arc Lighting Company of Chicago, and others, showing that the provisions for underground electrical conductors of the city of New York represent the best and most complete knowledge and experience of the subject.

Effect of Escaping Steam.

In a portion of the city, where the steam-heating company maintains an imperfect construction and allows steam to escape in large quantities from its pipes, serious damage to the electrical conductors in the subways has been caused.

This has been made the ground of an attack upon the system of subways laid in this city, and opponents of underground wires have not hesitated to assert that, because of this impairment of the efficiency of the cables where the steam was allowed to escape into the streets, the entire construction of conduits for electrical conductors is a failure.

The steam-heating company is at present endeavouring to stop this escape of steam from its pipes in the localities referred to, and has expended up to the present time more than a quarter million dollars in repairs of defective construction. Should it succeed in remedying the defects, the subways in the locality will again be effective. Otherwise the steam-heating company must either rebuild or cease from using this section of its plant.

In other localities of the city where the construction of the steam-heating company is proper, and steam does not escape, the existence of the steam-pipes in the same streets with the underground wires has no effect upon the latter.

The frequent explosions of illuminating gas escaping from leaky mains into subways, sewers, and house vaults is a matter which requires attention.

Electrical Connections.

In the matter of making electrical connections with the subways when constructed, the Board does not see good reason for departing from its original position of allowing the Construction Company to furnish whatever the several companies desire for themselves from the manholes to the points desired to be reached.

As soon as the subways are prepared along any street or avenue " sufficient in the opinion of the Board, reference being had to the general direction of the wires in use overhead," for the accommodation of the different electrical service, a notice is sent to the company operating such wires.

The way in which this resolution is drawn practically allows the companies operating wires to select their own methods of local distribution, while, at the same time, the authority of the commission over the Construction Company and its work, as well as the supervision of the Construction Company itself over the underground accommodations, is preserved.

This plan has been taken advantage of by some of the companies, and promises beneficial results. For example, the Construction Company has in some instances employed the hand-hole system of distribution for the use of telephone wires in down-town streets where it seemed desirable ; while at other points a single entrance into a block, in connection with house-top distribution, has proved sufficient. Again, in portions of the city where it seemed desirable, and where companies have requested it, the hand-hole system of distribution for electric lights has been provided, while in other streets where no local distribution is needed, accommodation for trunk lines only is considered sufficient.

To permit the various companies each to select its choice from among the many modes of distribution, and then to determine whether or no the choice is proper, and, if such choice be not proper or be not made, to prescribe a method, is not only entirely within the limits of authority of the Board, but for the direct benefit of the electrical companies as well.

The Condition of the Wires Overhead.

It is found that the condition of the overhead wires in the city is very bad. The rules of regulations of the Board of Electrical Control are violated everywhere. Unnecessary and "dead" poles and wires make up from 30 to 50 per cent. of all those existing. The poles made use of and the method of construction, as well as the way in which the wires are strung, are not in accordance with proper principles, nor in harmony with the character of the buildings along the streets, nor of a description enabling the freest possible use of the streets for other purposes.

On the contrary, the wires are almost uniformly dangerous, especially those devoted to the electric light service. They obstruct the fire department; the poles are found duplicated by other lines alongside of them, where one line would be ample for the business of both. The wires cross streets and enter buildings irregularly instead of at right angles, as they should; the poles are crooked, unpainted, different in size and shape; the cross-arms upon them are irregular, and the entire construction is unsightly and improper.

The Board has adopted a few general and easily comprehended rules and regulations for overhead wires, which, if followed, would relieve the overhead service from the danger and unnecessary obstruction which now attend it.

The general principles which have governed the Board in its dealing with the question are the following.

1. All useless poles and wires must be removed from the streets.

2. All dangerous currents must be carried on insulated wires, and the insulation must be maintained.

3. All poles must be of a sufficient size to keep the wires away from the sidewalk—sufficient to allow unobstructed operations by firemen.

4. One line of poles for each class of wires is enough in any street or avenue; and the telephone and telegraph wires must be kept on the opposite side of the street to those devoted to electric lighting

5. All the construction of poles and wires should be symmetrical, uniform, and safe.

Following these principles, the Board has held that wherever any company received permission to erect a line of poles and construct a line of overhead wires, it must allow its poles to be used by any other company desiring to do so, and offering proper compensation.

The carrying out of this method in all the streets of the city where there are no subways would be of the greatest benefit to the streets, and would enable all electrical companies to operate freely in any part of the city, thereby ensuring the best service at the cheapest rate to the public, without the duplication or multiplication of pole lines.

The question of operating electrical conductors in the subways successfully, as has been shown, has been thoroughly demonstrated, and every effort has been made to compel a proper condition of the overhead wires until subways shall be prepared throughout the city.

Final Action of the Board.

Owing to the disregard of the notices sent out by the Board of Electrical Control as to the dangerous condition of the overhead wires, and owing to the constantly increasing dangers from wires which did not conform to the rules and regulations, the Board of Electrical Control, on Wednesday, October 9, passed a resolution to the effect that thereafter no more dangerous currents should be operated on improperly insulated wires until such wires had been certified by the expert of the Board to be in good condition.

The resolution passed on Wednesday was served on the companies on the following Thursday, and in spite of it being in the interest of the public for the Board of Electrical Control to give such direction, such badly insulated circuits were in operation on Thursday and Friday.

Nothing could be done to remedy the evils, however, until December 20, when the injunction was vacated by the general term, and since that time the removal of dangerous poles, wires, and fixtures has been pushed with vigour and determination by the Department of Public Works.

The mistaken course of the electrical companies in refusing to care for their overhead wires, because the time was *not* far distant when they would be obliged to abandon them for underground wires, has caused suffering and death, and plunged the city of New York into temporary darkness. But the triumph of law is secured at last, and its majesty has been vindicated.

General Recommendations.

The experience in the past shows the necessity in the future for the most rigorous inspection of subways and wires within them, and of such overhead lines as still exist, until such time as subways shall be provided; and it is respectfully recommended that provision be made under which some one department, or official, or board, shall be vested with full power over the whole subject of electricity, and that the responsibility which has heretofore been divided, to the serious detriment of the public interest at times, should be consolidated.

In view of the frequent and constantly increasing dangers from other underground construction in this city than that for electrical conductors, and in view of the fact that a comprehensive system of subways which should include the pipes of the steam, gas, and other companies, as well as the cables for traction and the electrical wires, from which connections could be made to buildings without the removal of the pavements, seems to be required by the exigencies of the situation. It is also suggested that full power to cause the construction of such a comprehensive system of subways or sub-streets might well be vested in some official or officiel board at this time.

It is further suggested that whenever the Department of Public Works is called upon to remove defective poles and wires, or those provided for underground, the expense of the work of removal shall be borne by the electrical companies owning the defective or unnecessary lines.

The general report was accompanied by that of the electrical expert of the Board, Dr. S. S. Wheeler, containing various recommendations and the new rules just adopted by the Board. Referring to the condition of the underground electric light lines, Dr. Wheeler says:

"The results of the use of the underground conductors in the subways are very satisfactory. The tests of the conductors used for high-tension currents show that there is no deterioration perceptible in the cables by reason of such use as they have been subjected to, in some instances, for six months. Whenever imperfections in the underground circuits have been ascertained as existing, by the tests furnished by the companies, they have proved due to bad workmanship in making joints and connections, or the exposure of the ends of cables to the weather."

PROF. RUCKER ON ELECTRICAL FORCES.

The modern hypothesis of the nature and action of electrical forces was illustrated by a series of experiments in physics and optics performed by Prof. Rücker in the course of a lecture delivered last week to the members of the London Institution in Finsbury-circus. The familiar illustration of the attraction or repulsion of two pith balls suspended between two electrified spheres was used in order to show not merely the existence of the force, but the directions in which the force was exerted. The very fact that two electrified bodies attract or repel proved, said Prof. Rücker, that something must be going on in the space between them. That space appeared unchanged, though to the instructed eye it was as full of machinery as any mill. The truth of this proposition was shown by the introduction of two electrified bodies into dry ether, in which was sprinkled finely powdered sulphide of antimony. The powder arranged itself into lines of force vividly defined upon a screen and depending, of course, upon the nature of the electrical charge, just as iron filings dispose themselves when sprinkled upon a sheet of white paper over bar magnets, with like or unlike poles adjacent. Similar results were illustrated when, in place of electrified points, a small gold leaf electroscope was introduced into the liquid. As Faraday and Maxwell have shown, this force may be graphically represented as an inanimate muscle pulling the two bodies together, and having a tendency to contract in one direction and to extend in another direction, in the same way, as Prof. Rücker explained by a rough analogy, that a piece of indiarubber tubing contracts in one direction and extends in the other when stretched. That electricity exerts a similar kind of force, and produces similar effects upon the media through which it acts, was illustrated by means of light. By way of introduction to these optical effects, Prof. Rücker demonstrated the transparency and the opacity of two pieces of tourmaline according to the position of the crystals, and illustrated this optical law physically by the ingenious device of a French physicist. A long piece of silver wire was rapidly rotated by an electric motor. A section of the rotary motion was then converted into linear motion by the interposition of two sets of parallel glass pillars arranged vertically. Finally, one set of the pillars was placed horizontally, and the linear motion of one section ceased, just as the light ceased to pass through the tourmaline when the line of cleavage of one crystal was placed at right angles to the line of cleavage of the other crystal. This experiment, which has only recently found its way into the lecture-room, was repeated optically by throwing the light of a lantern through two prisms which passed or cut off the light according to their position. Stretched, squeezed, and bent glass were introduced into the path of the rays, and were shown to have an immediate effect in changing the condition of the medium, and in admitting light that had previously been cut off. Finally came a series of difficult and ingenious experiments arranged for the lecture-room by Prof. Rücker and Mr. Boys, with a view of demonstrating optically the effect of two different electrified bodies in a non-conducting liquid. Carbon bisulphide is placed in a small glass vessel conveniently placed before the lens of a lantern. In the liquid are arranged the conductors connected with a statical electric machine. These conductors may be, as was the case on Monday, two parallel metal cylinders, two plates—one convex and the other flat—or a section of a Leyden jar. The prisms were placed so as to cut off the light, and the plates or cylinders were then charged with positive and negative electricity. The immediate effect was to admit the light, varying from white to orange, red, purple, and green, as seen through a crystal of selenite, and proving the change that had been effected in the medium through which the force acted. The experiments were heartily applauded.

COMPANIES' MEETINGS.

AUSTRALASIAN ELECTRIC LIGHT COMPANY.

An extraordinary general meeting of this Company was held on January 30th, at the offices, 39, Coleman-street.

Mr. B. H. Van Tromp, who presided, said it would be in the recollection of the shareholders that when they last met he told them that there was a possibility of there being some little difficulty in getting the actual legal possession of the whole of the patents, and that it might be possible, for the present, at all events, there would be a small reduction made in the purchase money. When he told them, however, that their patents were 97 in number, relating to India, Tasmania, New Zealand, Natal, the Cape of Good Hope, Victoria, and all the Australian colonies, they might well imagine, having regard to the scattered provinces to which these patents referred, that there had been considerable difficulty in getting immediate possession of them. The Brush Electrical Engineering Company had called upon the Company to show its full title to these patents, and as regarded the greater portion of them the Board had made the complete assignment to that company. They had already executed, or would execute in the course of a day or two, the assignment to the Electrical Engineering Company of 73 of those patents, representing a value of £23,500 out of the £30,000, which was the total sum to be paid for the whole of the patents. The Directors had thought it better, in the interests of the Company, to complete the matter with the Brush Company to the extent indicated rather than wait until they were perfect as regarded the whole of the patents; but he had full belief that they would be able to show a good title to the whole of the patents. It was not proposed at the present moment to issue the shares representing the £23,000 to the shareholders, but the Board would obtain an undertaking from the Brush Company to issue them when required; and he hoped that in the course of a month or six weeks they would receive these shares and become shareholders in a prosperous concern. With regard to the winding-up, by the agreement in October last the right was reserved to the Brush Company to purchase the remaining assets for £15,000 on or before February 1st. Up to the present the Directors had received no intimation of the Brush Company's acceptance of these assets for £15,000, and his impression was that they would not do so, preferring that the Company should realise its own assets, as it knew where they were, and of what they consisted. He concluded by moving resolutions to the effect that the Company be wound up voluntarily, and that the liquidators be directed to complete the agreement entered into between the Company and the Brush Electrical Engineering Company.

Mr. Rowan seconded the resolutions, which were carried unanimously.

CUBA SUBMARINE TELEGRAPH COMPANY.

The thirty-seventh ordinary general meeting of the Cuba Submarine Telegraph Company, Limited, was held at the offices, Old Broad-street, under the presidency of Mr. Thomas Greenwood.

The **Chairman**, in moving the adoption of the report, stated that the expenses had been about £1,500 more, while the receipts had been about £1,500 less than those of the corresponding period of the previous year. These differences accounted for the transfer on the present occasion of only £1,000 to the reserve fund, compared with £4,000 a year ago. The whole of the additional expense had been occasioned by the cost of the repairs of the Batabano-Cienfeugos cable, and by the amount paid to the Government for the use of their wire during the short time the Company's cable was broken. With regard to their tariff, the through rate used to be 67c. per word, whereas it was now 50c. The Directors congratulated themselves and the shareholders on the fact that this large reduction in the rate had been followed with such a small diminution in the average receipts. The returns for last month had been £3,150, against £3,220 for January, 1889, and he hoped that they would have as large an income from the lower rate as they had had from the higher. Notwithstanding this reduction in the tariff, and the other facilities they had given to the French company, the latter had applied to the Spanish Government for permission to have a line by land, or a cable by sea, almost parallel with the Cuba Company's lines. The Directors had protested against this demand. Nevertheless, a royal order had been issued refusing the land line, but conditionally granting a cable from a place adjacent to the Cuba Company's eastern terminus at Santiago, with which the French Company already had telegraphic communication, along the north coast to Havannah, the Cuba Company's western terminus. The proposed line, if allowed, would therefore take from the Cuba Company the whole of the traffic under the control of the French company, but now carried by the Cuba Company, and might be in competition, by the north coast, with the Company's lines on the south coast. They had therefore felt obliged to commence proceedings in the proper court in Madrid to protect their concession and interests.

Mr. Alexander F. Low seconded the motion, which was adopted, and a dividend on the ordinary shares at the rate of 9 per cent. per annum, tax free, was afterwards declared.

ANGLO-AMERICAN TELEGRAPH COMPANY, LIMITED.

The half-yearly general meeting of this Company was held last Friday at Winchester House, Old Broad-street.

Viscount Monck presided, and in moving the adoption of the report and the payment of final dividends of 15s. per cent. on the ordinary consolidated stock, and £1. 10s. per cent. on the preferred stock, making total dividends, for the year ended December 31, of 2¾ and 5½ per cent. respectively on these stocks, the Chairman observed that the addition to the dividend was undoubtedly small, but he thought that in connection with the explanation contained in the report it was not discouraging, and it contained the element of hope for the future. They were carrying on their traffic under two distinct arrangements. With the Direct United States Cable Company and the Western Union Company of New York they had what was called a joint-purse arrangement. They all paid their receipts into a common fund, and received from it a proportion of the aggregate. On the other hand, the parties to this arrangement and the Commercial Cable Company of New York had an agreement by which the tariff was fixed at a certain rate, and they all took as much as they could get at that rate. He believed that that arrangement had been fairly and honourably carried out on both sides, but it must be apparent to them that it introduced the element of competition, and that any circumstances which might arise to interfere with the carrying power of either of the parties to that transaction would very prejudicially affect their income from the arrangement. This was precisely what had happened to them during the past half-year. One of their own cables—the old Brest cable of 1869—was twice out of work; the cable of the Direct United States Company was for a while inoperative, and the two cables of the Western Union Company were also disabled, while during the whole time the cables of the Commercial Company, which were their competitors, were working uninterruptedly and with good effect. With reference to this question he desired to emphasise the remark of Sir John Pender at the meeting of the Direct Company—that it was the first duty of the boards of the associated companies to keep their cables constantly in repair, and whenever a mishap occurred to take care that the repair was effected with the greatest possible expedition. Of course, what had occurred was the fortune of war, and they had no right to complain of it as against the Commercial Company. He only mentioned it in order to explain why they were not able to distribute a larger dividend than they proposed on the present occasion. The Company's cables were now in good working order. The expenses for the past half-year looked larger than those of the previous half-year, but if they came to analyse them it would be found that the increase wholly consisted of extraordinary expenses, restoration of buildings, etc., which were not likely to recur for a long time, and which could not be treated as normal expenditure. Within the last year they had executed two works. One of them was referred to at the last meeting—the relaying of the St. Pierre-Duxbury cable in deep water. It had been for many years a source of vexation and expense to them by its liability to injury from the shallowness of the water in which it had been laid. He trusted now that it would give them no further trouble. The other operation referred to was that by an arrangement with the Western Union Company they had obtained the command of cable lines into New York City, where they had established an office of their own. These lines would not only put them in direct communication with their customers at New York, but would also obviate the inconvenience, to which from his residence in America he could personally testify, of the constant interruptions of the land lines in winter and spring by snow and storms. They had often had discussions at their meetings with regard to the renewal fund. He did not want to raise any question respecting it upon that occasion, but he thought it would be satisfactory to the shareholders to hear that that fund, which now stood in their books at £923,344, had been so well invested that it was worth at present quotations about £60,000 more. With the spare cable in reserve they had fully £1,000,000 for any purpose to which they might have to apply it. He then referred with great regret to the loss which the Company had sustained since their last meeting by the death of Sir Daniel Gooch, who, he stated, was an original member of the Board, and who had contributed almost as much as any man to the establishment and development of ocean telegraphy. To fill the vacancy thus occasioned they had elected Mr. Charles Burt, who, from his long experience of the business of the Company and his great capacity, was regarded as a worthy successor of their late colleague.

The **Marquis of Tweeddale** seconded the motion.

In reply to questions, **Lord Tweeddale** said he could assure the shareholders that everything had been done and would be done by the Directors to bring to a close the litigation between the Company and the Paris and New York Telegraph Company. They could not, however, bring any influence to bear on the French Courts, but they had reason to believe that the case would be settled before the next meeting of the Company six months hence. It was inevitable that a company which lost three of its cables must be crippled with reference to the traffic which it might expect. The traffic between this country and America was crowded into a very few hours, and, of course, the more cables they had at their command the more expeditiously was the work transacted. With regard to something being done to increase the income, the time had long since arrived for doing it if it were possible, but the shareholders must remember that the tariff could not be fixed by themselves. They had not only influential partners, but also opponents, and until they all agreed with reference to the tariff it would be impossible to make any alteration, even if a change were desirable. He thought, however, that the impression on their minds and those of their friends was that it would not be desirable to make any alteration in the existing tariff. If they were to increase it, there was every reason to suppose that they would attract further competition, for the Atlantic Ocean was open to anyone. Nearly £18,000 had been charged to the renewal fund for the repair of the Brest-St. Pierre cable and the repair and diversion of the St. Pierre-Duxbury cable, and £17,800 had been charged to revenue account for the expenses of the ship "Minia," the value of the cable expended, and the charter of the "Britannia."

The report was adopted, and the retiring Directors and Auditor were reappointed, and Mr. John Gane was elected an auditor in the place of Mr. F. Glass, resigned.

NEW COMPANIES REGISTERED.

Universal Electrical Light and Power Trust Corporation, Limited.—Registered by F. B. Harvey Samuel, 1, Whittington-avenue, Leadenhall-street, E.C., with a capital of £5,000 in £10 shares. Object: to invest the moneys of the corporation in, or otherwise acquire and hold the shares, stocks, bonds, obligations, debentures, debenture stock, scrip and securities of any company, trust, or corporation formed under British, foreign, Indian, and colonial law, and in particular of any company, trust, or corporation formed for the supply of the electric light, heat, or power to towns, streets, buildings, and other places, or their application to any other public or private purposes. The regulations of table A, with trifling alterations, apply.

CITY NOTES.

Eastern Extension, &c., Company.—The receipts for January were £40,610, against £41,820.

West Coast of America Telegraph Company.—The receipts for the month of January amounted to £6,225.

Cuba Submarine Telegraph Company.—The receipts of this Company for January were £3,150, against £3,221.

Direct Spanish Telegraph Company, Limited.—The receipts for the month of January were £2,415, against £1,880.

Brazilian Submarine Telegraph Company.—The traffic receipts for the week ended January 31 amounted to £5,249.

Eastern Telegraph Company.—The traffic receipts for January were £59,478, as against £65,835 for the same period of 1888, or a decrease of £6,357.

West India and Panama Telegraph Company.—The traffic receipts of this Company for the half-month ended January 31 were £3,551, as compared with £2,900. The October receipts, estimated at £4,770, realised £4,799.

Western and Brazilian Telegraph Company.—The traffic receipts for the week ended January 31, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,996.

PROVISIONAL PATENTS, 1890.

January 27.

1390. **An improvement in connecting wires with attachments for connecting to electric batteries or other firing arrangements.** William Balch, 7, Field-view, London Fields, Hackney, London.

1391. **An improved electric firing battery and cells.** William Balch, 7, Field-view, London Fields, Hackney, London.

January 28.

1495. **Improvements relating to storage batteries or accumulators.** Henry Harris Lake, 45, Southampton-buildings, Middlesex. (George Augustine Johnson, United States.) (Complete specification.)

1516. **Improvements in electric light fuses or cut-outs.** James Ernest Spagnoletti and Joseph Crookes, 39B, Goldhawk-road, Shepherd's Bush, London.

1529. **Improvements in electric signalling apparatus.** John Daniels Taylor, 53, Chancery-lane, London.

1530. **Improvements in measuring of electric currents and in apparatus connected therewith.** Johan Wilhelm Theodor Olán, Marstrand, Sweden.

January 29.

1534. **Improvements in driving gear for electrically propelled cars or vehicles.** George Wilkinson, 2, Prince's-mansions, Victoria-street, London.

1554. **An electrical head piece and reins combined, for preventing restive horses and other animals running away.** Girolamo Cafiero, 11, Commercial-road, Gloucester.

1555. **An improved magnetic separator.** George William Elliott, 160, Shirebrook-road, Heeley, Sheffield.

1559. **A combined ceiling rose, cut-out, and switch for electric lighting purposes.** Harry Cecil Blackwell, 2, February-street, Chorlton-upon-Medlock, Manchester.

1596. **Improvements in electric lamps or lighting apparatus.** Henry Harris Lake, 45, Southampton-buildings, Middlesex. (Frederick Clarence Jenkins, Germany.)

January 30.

1618. **A method of and means for automatically breaking and making an electric circuit.** John Michell Grylls Trezise, Surrey House, Victoria Embankment.

1619. **Improvements in or pertaining to electric bells or gongs.** Louis Shilton, 186, Fleet-street, London.

1629. **Improvements in or relating to electric accumulators.** Alfred Julius Boult, 323, High Holborn, Middlesex. (Giovanni Garassino di Giovanni, Italy.)

1638. **Electric automatic railway alarm and signalling device and apparatus.** Henry Merritt Harcourt, 46, Lincoln's-inn-fields, London.

1644. **Improvements relating to electric traction.** Alexander Login Lineff, 6, Bream's-buildings, Chancery-lane.

1646. **Improvements in safety devices for electric lines.** Pharour Chadderton Brewster, 226, High Holborn, London.

1658. **Improvements in and connected with electricity meters.** Chaimsonovitz Prosper Elieson, 4, South-street, Finsbury, London.

January 31.

1700. **Improvements in arc lamps, and relates to means for feeding the carbons together and also striking the arc.** Charles Newton Russell and Ronald Augustus Scott, 17, Heathfield-road, Mill Hill Park, London.

February 1.

1768. **Improvements in apparatus for electrically indicating or recording the number of times that a closet lavatory or the like is used.** Julius Sax and Edward Donohoe, 47, Lincoln's-inn-fields, London.

SPECIFICATIONS PUBLISHED.

1889.

656. **Measuring electric currents.** Dines and Gatward. 6d.

1038. **Electric lamps.** Rees. 8d.

1480. **Electric meters and motors.** Wright and others. 11d.

2168. **Electric meters.** Thompson (Tudor). 8d.

2176. **Electrical instruments, &c.** Rawson. 6d.

2313. **Applying electricity.** Lawrence. 8d.

2331. **Decomposing substances by electricity.** Dowland and another. 6d.

3103. **Electrical measuring instruments.** Hibbert. 8d.

3907. **Electrical switches.** Parker and Rees. 6d.

12286. **Electric current meter.** Sir C. S. Forbes. 8d.

19420. **Alternating current electro magnetic motors.** Lake (Tesla). 8d.

19426. **Alternating current motors.** Lake (Tesla). 8d.

19484. **Electric switches.** Andersen. 8d.

19861. **Secondary batteries.** Logan. 8d.

19861A. **Secondary batteries.** Logan. 6d.

19883. **Electrical secondary batteries.** Pumpelly and Thomason. 8d.

19899. **Electric batteries.** Thompson (Parrish). 6d.

19946. **Telegraph transmitters.** La Dow. 8d.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Anglo-American Brush	—	2⅝
— Pref.	—	1⅞
India Rubber, Gutta Percha & Telegraph Co.	10	17¾
House-to-House	4½	5
Metropolitan Electric Supply	—	4½
London Electric Supply	5	3½
Swan United	3½	5½
Telegraph Construction	12	45
— 6%, 1889	100	105
National Telephone	5	6¼

NOTES.

Telephones in France.—A decree has been passed in Paris allowing private subscribers to use the public call offices free of cost.

The Telegraph in Beloochistan.—Apozai, the new head quarters of the Zhob agency, will shortly be joined by telegraph with Quetta.

Telephone in Russia.—Successful experiments have just been made by telephone between St. Petersburg and Moscow over ordinary telegraph wires.

Ferranti Cables.—The work of laying the Ferranti cables from Deptford to Charing Cross is now being pushed forward. About 3½ miles are already laid.

Sleigh-driving by Electricity.—A Russian company are at present making experiments in electric traction upon ice, the trials having been made upon the River Neva.

Shanghai.—The new electric light company at Shanghai has paid a dividend of 7 per cent. for the year ended the 31st October last—the first year of its working.

Electric Tramway in Holland.—The first electric tramway in Holland is to be opened on March next, from the Hague to Schevingen, a distance of about four to five miles.

Society of Arts.—On Wednesday next Prof. Silvanus Thompson will read a paper before the Society of Arts, on "The Organisation of Secondary and Technical Education in London.'

Dordrecht.—The municipal authorities of Dordrecht have entered into a contract for the public lighting of their streets by electricity, for the amount of £13,000. The mains will be underground.

Weymersch Battery.—Steps are being taken to push the Weymersch primary battery, recently satisfactorily tested for some months at Silvertown, and offices have been taken at Victoria-mansions, Westminster.

Royal Meteorological Society.—At the next meeting of this society at 25, Great George-street, Westminster, on the 19th inst., a paper will be read by Mr. Eric S. Bruce on "An Optical Feature of the Lightning Flash."

The French Atlantic Cable.—A Reuter telegram from Penzance says that the cable steamer, "Mackay Bennett," has successfully completed the repairs to the English-Brest section of the French Atlantic cable.

Incandescent Lamps without Vacuum.—It is stated that the Société Française d'Eclairage Electrique are occupied in working out a system of electric lighting by incandescence in the ordinary air without a vacuum.

Medical Electricity.—We are in receipt of a pamphlet containing four articles upon the employment of constant-current batteries for treating the human body, as used by Mr. W. Grigg, of 33, Eastbourne-terrace, Hyde Park.

Allerton.—The people at Allerton, Bradford, are dissatisfied with the gas. The lead of Bradford is probably affecting this district, and the refusal of the company to reduce the price is also in favour of the introduction of electricity.

Award.—At the recent International Electrical and Industrial Exhibition held at Birmingham, Messrs. Robey and Co., of Globe Works, Lincoln, were awarded a special first class gold medal for their high-speed engine fitted with patent electrical regulator.

Transformer Patents.—The petition of Max Deri (Ganz and Co.), of Budapest, against Gaulard and Gibbs for an annulment of patent for transformers, has resulted in a decision in favour of M. Deri on the ground of previous publication by Paul Jablochkoff and others.

Seed Cleaning.—A 1 h.p. C & C motor has been put into a seed establishment, for cleaning a machine hitherto turned by hand, the man having to lift and discharge the seeds. Now the motor does all, and works the elevator and cleans the grain as fast as it can be fed.

University Extension Lectures.—The second of a course of lectures on "Electricity, its Sources and Uses" (in connection with the Oxford University Extension) was given by Mr. V. P. Sells, M.A., F.S.C., in the Princes-street Lecture Hall, Gravesend, on Monday evening.

A Rotary Arc Lamp.—The demand having arisen for lamps requiring less attention for trimming, a new rotary arc lamp has been introduced by Messrs. Heymann Bros., of Boston, U.S. This lamp has carbon discs instead of pencils, and these revolve as they wear away, lasting 40 to 50 hours.

Royal Institution.—Prof. J. A. Fleming reads a paper this (Friday) evening at the Royal Institution, Albemarle-street, on "Problems in the Physics of an Electric Lamp." Lord Rayleigh's first lecture on "Electricity and Magnetism," before the Royal Institution, will take place to-morrow, Saturday, at 3 p.m.

Personal.—Mr. Holland Dell, late secretary to the Electrical Power Storage Company, has been appointed sole representative for the United Kingdom and colonies of the well-known Paris carbon manufacturers Messrs. Lacombe and Co., whose London offices are at 7, Little Queen-street, Westminster, S.W.

Fire Brigade Lanterns.—The San Francisco fire department are introducing electric lanterns containing two 3-c.p. lamps and reflectors, weighing about 10lb., to furnish light for five hours. Headlights for the engines are also provided using 20-c.p. Bernstein lamps and run with seven cells, which last for eight hours.

Bradford Station.—The new Midland station and hotel at Bradford is being lighted up with electric light, the offices by incandescent and the station itself by arc lights. The engines and dynamos are placed in the bonding warehouse. The work is being carried out by the company's own engineer, and will shortly be ready to start.

Fareham.—It will be seen from the advertisement appearing elsewhere that application for shares can be received for the Fareham Electric Light Company. The Thomson-Houston system will be used, and the continued success of this system at Taunton, chronicled in this same number, should lead to the company being well supported.

Ship Lighting.—The electric light is now found to be an indispensable adjunct to the shipbuilding trade and no new passenger steamers are sent out without being fitted. Several of the leading shipbuilding firms in the North have taken the matter up themselves, and have added an electrical department to their work, and now fit up the electric light in the vessels which they build.

Units.—The *Western Electrician* publishes an interesting sheet of portraits of eminent scientists whose names have been adopted at one time or another as electrical units, comprising Watt, Faraday, Joule, Gauss, Weber, William and Werner Siemens, Volta, Ampere, Daniell, Jacobi, and Ohm. It is accompanied by a biographical article by F. B. Badt, and has evidently been the work of no little trouble and research.

Three-Wire Dynamo.—A description is given in the *Electrotechnische Zeitschrift* of the system proposed by Mr. Hermann Muller, for the employment of a single dynamo for the three-wire system of distribution. A two-pole dynamo is furnished with three brushes, two at opposite sides of the commutator and the third part way between, the latter being connected to the central neutral wire of the mains.

Van Rysselberghe System in Austria.—We have recently chronicled the successful installation of the Van Rysselberghe combined system of telephony and telegraphy in Monte Video. It is announced, on the other hand, that the Austrian Minister of Commerce has decided to give up the system between Vienna and Brunn, and will commence the construction of a special telephone line between these two towns.

House of Commons.—The new installation at the House of Commons was started on Tuesday at the opening of Parliament, and proved a complete success. The work has been carried out by the Westminster Electric Supply Corporation, who have established a temporary station in the stoneyard at the back of the Houses pending the time that their permanent station is being constructed, after which the House of Commons will be connected to the street mains.

Hanover Square.—Before the St. George's, Hanover-square, Vestry, it was recommended that the Vestry give their consent to the application of the Chelsea Electricity Supply Company for a provisional order of the Board of Trade, authorising the company to supply electricity in the Knightsbridge and out wards of this parish; and also that the Vestry give their consent to the application of the same company for a license from the Board of Trade for the same purpose. The motion was carried.

Electric Mutual Insurance.—The announcement is made of the formation of an electric mutual insurance company in America, which it is hoped will serve to allay the considerable excitement which has recently taken place in America, and which, if its work be faithfully carried out, cannot fail to benefit the electric industry of the United States. The insurance rates will be low, and periodical visits will be made by an inspector, who will naturally have opportunities of observing the best practice in other stations.

An Electrical Engineer for Dublin.—At the meeting of the Dublin Corporation on Monday, the standing order was suspended to have the report of the Electric Lighting Committee recommending the appointment of an electric superintendent. Mr. Robinson moved the adoption of the report, which recommended the appointment of an electric lighting engineer at a salary of £200 a year with increments. Mr. Miley moved that the salary should be increased to £300, as he did not think that an efficient man could be obtained for £200. After some discussion, the amendment was withdrawn, and the report was adopted.

Electric Candle.—A novel and decidedly tasteful form of incandescent lamp has just been introduced, and is manufactured by the Edison-Swan Company. It is intended to stand upright, point upwards, to be fitted on a candlestick, such as the numerous wrought, chased, and wreathed candelabra of the Louis XVI. style, or of course can be adapted to ordinary standards. The peculiarity is that it is elongated and twisted in the form of a flamboyant spiral, so that when alight it has much the appearance of a flame. It is made in obscured or frosted glass, and is a tasteful addition to the forms of electric light for house decoration.

Van Rysselberghe Central Station.—M. Bède, before the Société des Ingenieurs et Industriels at Brussels, severely criticised M. Van Rysselberghe's scheme for the establishment of a central station, stating that, according to actual figures taken from the Berlin installations, the five million francs asked by M. Van Rysselberghe for a station of 17,500 16-c.p. lamps should give more than 40,000 lamps. M. Bède finds only three explanations of M. Van Rysselberghe's figures: either he is considerably mistaken in his calculations, or he wishes to make the town pay very dearly for the risk he undertakes, or else his system is excessively costly.

Telephoning at Sea.—Lieutenant Fiske, in a lecture before the Franklin Institute, mentions some interesting experiments with regard to the telephoning between vessels at sea in which he had taken a prominent part. These experiments were undertaken in the Brooklyn navy yard A large dynamo was used to provide current, and in one case the cruiser "Atlanta" was converted into the largest electromagnet known, being wrapped with heavy electric wire through which the current from the dynamo was passed, while the iron tug "Nina" was converted into a telephone receiver, being wrapped with fine wire with a telephone in current.

Austria.—The extension of the central station at Vienna established by MM. Fischer, Siemens, and Halske seems to have encountered a large amount of unlooked-for opposition. Although constructed for 60,000 lamps, it hardly serves 5,000. The station established after the designs of Prof. Englander is very prosperous; it now feeds 12,000 lamps, a large number being for private houses, but many also for the public streets. The plant contains five steam-engines, ten dynamos of various types, and a battery of accumulators as regulator of current. The works of construction for the station of the International Electricitats Gesellschaft are being pushed forward with great activity.

Coffin's Method of Electric Welding.—What is claimed as an improvement upon Prof. Thomson's system of electric welding is introduced by Mr. Ch. L. Coffin, of Detroit. In effect, it consists of the introduction of the field from a strong electromagnet just at the point of weld. This, it is claimed, increases the electrical resistance of the joint to the amount required, and the heating effect of the current becomes greater. Mr. Coffin has also found that the better weld is obtained, not by continued pressure when the metal softens, but a slight stress tending to separate the metals while the current is still passing, taking care not to rupture the weld. The joint is finished off by hammering or rolling in the ordinary way.

Scottish Telephone Directory.—Mr. A. R. Bennett, general manager for the National Telephone Company in Scotland, has forwarded to us a copy of the Scottish Telephone Directory for 1890, a well-bound volume in neat red cloth, gilt-lettered, of some 280 pages. It is full of the names of the subscribers to the interurban telephone system in Scotland and Cumberland, extending down south to Carlisle, and northwards to Edinburgh, Glasgow, Paisley, Greenock, Perth, Dundee, and Aberdeen. A map showing the trunk lines now erected and proposed is given as the frontispiece, and is a pleasing proof of the extent to which the telephone service is being pushed by the activity and enterprise of its manager in Scotland.

Croydon.—At the meeting of the Croydon County Council, the sub-committee appointed with regard to the electric lighting orders reported that they had settled objections and amendments to be made to the three draft electric lighting orders. They further reported that the Croydon Electric Light Company and the South of England House-to-House Electric Light Company do not concur in the terms in which the Council should have an option of purchase, and that the Croydon company had suggested alternative conditions. Upon the suggestion of the sub-committee the committee recommend as follows: That the order promoted by the South of England House-to-House Electric Light Company be opposed. The report was adopted.

Strand Lighting.—The Metropolitan Electric Supply Company have written to the Strand District Board giving notice of their intention to lay mains in the Strand, from Burleigh-street to Catherine-street, and up Catherine-street as far as Exeter-street, and in Leicester-square, Cranbourne-street, Charing Cross-road, and Great Newport-street; also in Dean-street, across Shaftesbury-avenue, and down Macclesfield-street, and across the Strand, down Savoy-street, Church-row, and Church-hill. It was intimated to the same authority, on behalf of the Electricity Supply Corporation, that they would not proceed with their provisional order. Both of these letters were referred to the Lighting Committee. The Board will take objections to Messrs. A. and S. Gatti's provisional order for supplying electric lighting to the whole of the district.

Proportion of Lighting.—House lighting in Berlin, in spite of the general progress made in that city, does not seem to have extended in a proportional manner to that of other spheres of more public nature. In fact, the slight extra expense over the cost of gas would seem to have acted as a great deterrent against the adoption of electricity in private houses, while the shops, cafés, and theatres have willingly gone for the better light. The recent returns of the electric company show that only about 400 private houses are customers for the light. The following is an interesting analysis of the proportions of the distribution:

Cafés and restaurants	10 per cent.
Shops	34 "
Banks and offices	21 "
Theatres	27 "
Private houses	4 "
Various	4 "

Underground Conduit.— A novel conduit has recently been patented by Mr. James Tatham, and promises, says the *Electrical World*, to completely revolutionise the wire conduits at present in vogue. The construction of this new conduit, in brief, consists of an iron pipe, having inside a thin lead pipe, covered with a textile fabric, saturated with an insulating compound. A hydraulic expander being placed within, the lead pipe is then expanded, and the insulating material is forced into intimate union with the iron and lead. The lead is, however, practically insulated from the iron, and a cable, or any number of cables, simply saturated in an insulating compound, may be drawn through the conduit without previously having the customary lead encasing. The process may be applied to any size of pipe. An ingenious device is provided for making the proper joints and carrying out the branches.

Coppering Tail Shafts of Steamers.—A correspondent of the *Steamship*, with reference to the Elmore copper depositing process, makes a suggestion which possibly may prove of great practical utility in the shipbuilding trade. In alluding to the deposition of copper upon a mandril, this, he says, suggests to him a method of protecting the tail-end shafts of steamers from corrosion, and he enquires if this could be done, and at a cost low enough for its adoption in ordinary cargo steamers. It is well known that tail shafts often suffer from corrosion within the stern tube, due to the galvanic action set up between the gunmetal liners and the iron by means of the salt water. This occurs more especially just at the ends of the liners, and, as the shaft cannot be inspected except by drawing out, the deterioration may go on for a long time unsuspected, and very serious consequences ensue. What is proposed, to obviate this, is to shrink the liners on in the ordinary way, and to cover the whole of the intermediate portion of shaft with a thin layer of copper by means of the above process.

St. Pancras.—On Wednesday the St. Pancras Vestry decided, in accordance with a recommendation of the Electricity Committee, to pay Dr. Hopkinson, F.R.S., one hundred guineas in consideration of the committee and Prof. Robinson being at liberty to consult him from time to time on the details of the installation and preparation of plans, specifications, and estimates for carrying out the same up to the time of advertising for tenders. At the same meeting, Messrs. Bircham and Co., parliamentary agents to the Metropolitan Electric Lighting Company, intimated the desire of this company to supply the south end of Tottenham-court-road, and asked for the Vestry's authority to lay their mains across that part of St. Pancras. The request was not complied with, as the committee "considered it undesirable to allow a company to have any powers in the parish, and especially as the cost of carrying their mains round the point of the parish could not be great, seeing that the company intended supplying the whole district bordering on this part of St. Pancras."

Telegraph Wires on the Forth Bridge.—An incidental benefit accruing from the erection of that gigantic engineering feat, the Forth Bridge, is that telegraph and other electric wires crossing to the North of Scotland, which have hitherto been laid in cables under the Forth, can now be run along the bridge. This will avoid the expense caused by damage from anchors. When the communication by the viaduct has been properly established it is proposed to remove most of the cables in the Forth. Altogether 50 wires are being laid across the bridge, enclosed in two tubes, 20 for the use of the North British Railway Company, and 30 for the use of the General Post Office. The wires are being drawn through the tubes, 2in. iron pipes, in lengths of 118 yards and 250 yards. The cables which will be lifted at Queensferry are three in number, and each contain seven wires. At Burntisland there are four cables, which will be lifted also, but the cable from Granton to Aberdour will be allowed to remain. The work, it is expected, will be completed on an early day.

Westminster Supply.—It has been stated in print that Mr. J. E. H. Gordon has been appointed electrical engineer to the Westminster Electric Supply Corporation. This report is evidently based upon the fact that Mr. Gordon, in common, we believe, with Mr. Gisbert Kapp, has received a retaining fee to act as consulting engineer when occasion arises. The company, whose offices are at Victoria-mansions, Westminster, have we understand, appointed Mr. Elphinstone, lately with Messrs. Ferranti, as their acting electrical engineer. Sir William Thomson and Prof. Kennedy are consulting engineers to the company. The company are making arrangements for the speedy erection of a central station, near the Houses of Parliament, on the banks of the Thames. A low-pressure current will be used, with storage batteries, 100 volts at the houses. It is understood that the Siemens six-wire system will be employed for part of the circuit, but in general the method will be similar to that employed at Knightsbridge by Mr. Crompton. Another, or possibly several other stations will be erected further north of the Thames.

Tesla Motors for Mining.—We have been waiting long to hear of the first application of the much talked-of Tesla alternate-current motor in practice. This first practical application has now been made for mining purposes, and seems to have been a thorough success, and the certainty of its extensive adoption appears to be regarded as certain. The Tesla motor was used to drive a Hercules mining machine, invented by Mr. E. E. Carter, of Pittsburg, and used in the coal mines of the Monongahela Gas Coal Company. Compressed air was first used for this coal cutter, but electricity was afterwards suggested, and since the application of the motor nothing could be more satisfactory. In operation with the Tesla motor, it can be worked by one man, and its production represents 600 square feet floor space in 10 hours. The machine wants little attention, and the man may leave it to attend to the next shift. The success of the experiments have induced the coal company to put in a number of machines, and the Hercules Mining Machine Company has made a contract with the Westinghouse Company for a large number of Tesla motors.

Bare Underground Wires.—The desire for simplicity of construction and ease of manipulation have led some of our companies, notably Messrs. Crompton and the St. James's Electric Lighting Company, to the adoption of bare strips of copper insulated by porcelain or glass in underground troughs instead of the carefully insulated cables at first used, and almost entirely employed we believe in America, in cases where underground mains are laid. For comparatively low-tension systems of distribution the method evidently has many practical points in its favour, on the scores of ease of laying, inspection, and connection. The proposal has been made to ventilate these underground troughs by constantly running ventilators by which warm dry air would be forced through to keep the insulation high. Whether it will be found necessary or considered desirable to arrange such a method of ventilation, we are not yet prepared to say. But the system of bare underground mains seems to be spreading on the Continent, and experience upon the system under various circumstances will be forthcoming. In Paris it has already received considerable development, and in Germany the Allgemeine Gesellschaft of Berlin are employing this system of mains in the extension of their central station lighting.

Electrical Phenomena in Nature.—An interesting lecture was given at the London Institution on Monday, upon the electrical phenomena in nature, by Mr. Shelford Bidwell, who dealt with the subject mainly as it related to thunderstorms. Referring to the controversy initiated by Dr. Lodge as to the value of electrical conductors, the lecturer gave illustrations on the screen to show that such conductors were of considerable use during a period of steady electrical strain, while when an impulsive rush came it would probably fail to stop the discharge. The most a lightning-conductor could do in the case of an impulsive rush was to bear the brunt of the discharge; but then it became a source of danger, because sparks might fly off it and do damage. In all cases of steady strain, however, a lightning-conductor was good; in the majority of cases it was of great service; yet it could not always be relied upon as affording immunity from risk. As to the danger to life from lightning, it had been shown from the Registrar-General's returns that in 29 years in England and Wales the deaths from lightning had occurred at the rate of only one in a million of the population per annum. This was so small a percentage as to be scarcely worthy of note; and, said the lecturer amid laughter, one was almost as likely to be hanged for murder as to be killed by lightning.

A Conduit System without Slots.—An inventor in Newark, U.S., has constructed an electric railroad on one of the wharves of that city, says the *Electro-Mechanic*, to demonstrate a new principle in electric propulsion. It not only does away with overhead wires, but with continuous contacts as well. It is a conduit system, but the conduit is without a slot, and is practically water-tight and air-tight. To keep it dry a blower or exhaust fan will force air constantly through it. The conduit is placed midway between the rails, and in the full-sized model it is made of wood, with a series of heavy brass plates on top. In the bottom of the conduit is an insulated copper strip. The brass strips forming the cover of the conduit are four or five feet in length, and are rubbed by copper brushes, which conduct the current to the motor in the car. Elsewhere the current is flowing peacefully along the copper rod in the bottom of the conduit. Connection between the copper rods and brass plates is formed by permanent magnets preceding the brushes under the car. These magnets pick up successive pallets or levers in the conduit, and the pallets form contact between the rod and the plates. As soon as the car passes one of the strips the levers drop of their own weight and break the circuit in the conduit. One of the rails is used to form the other half of the metallic circuit, as in overhead systems. The model car carries six persons rapidly, with a current measuring 70 volts. A practical road is to be put down in one of the suburbs of Newark.

Scarborough.—A letter was published last week in the local paper addressed to the town clerk of Scarborough from Mr. George Offor, managing director of the Electric Construction and Maintenance Company, Limited, in October last submitting the following proposition for "obtaining an order upon a mutuality of interests—viz.: That your Corporation should give their consent to our application, the terms of the order to be free from clauses unduly onerous, we agreeing not only to divide with your Corporation the profits beyond an agreed minimum, but also to accept conditions in the order, under which your Corporation should have the right at any time hereafter to acquire the whole of the undertaking at a price to be ascertained by capitalising the profits of the company at 5 per cent.—if the profits of the company shall then exceed 5 per cent.—or upon the basis of the actual capital expenditure of the company, or if the profits shall not exceed 5 per cent. the purchase-money in either case to be paid by the bonds of your Corporation redeemable 21 years after date. The effect of this arrangement would be that, if the company were showing a profit of 7 per cent., your Corporation would naturally make the purchase and enjoy the advantage of the larger profit; while, on the other hand, if the company were unable to pay a dividend, your Corporation would not be likely to purchase; but the company, on the other hand, having secured the goodwill of your Corporation, by an arrangement such as that proposed, might enable the Lighting Company to tide through commercial difficulties which under a stringent order, or without the goodwill of the Corporation, would probably be disastrous." Commenting upon this, which as yet has not been publicly discussed, the *Scarborough Post* says: "Compared with some towns we pay through the nose for our gas, and it would be a decided advantage if we could get electric light at a cheaper or even the same rate, for there is no question as to which is the best. The offer is liberal enough, and if the number of gas shares held by the members of the Corporation are not too weighty probably we may get the electric light after all."

New Taunton Central Station.—The success of the electric lighting on the Thomson-Houston system, introduced at Taunton by Mr. Massingham, has led to the extension of the system. The company have now given up the old premises at the rear of Mr. Massingham's shop, which were at first sufficient for the company's requirements, in order that new and improved machinery might be laid down. A more central position was found, being the site of premises recently burnt to the ground, which the company were able to secure. They have erected on the site a substantial block of buildings, fitted up with modern machinery of the best type. A large stack, 120ft. high, 8ft. at the base, and 4ft. at the top, denotes the locality of the works. The boiler-house, which is 100ft. by 40ft., is fitted with two of Babcock and Wilcox patent water tube boilers, each of 150 h.p., and working at 140lb. per square inch. This is four times the power the company had at the old works, and will enable ample provision for an extension of the system. In the engine and dynamo room, which is 100ft. by 50ft., are two of Ruston and Proctor's 75-h.p. horizontal compound engines, which will drive through a countershaft four Thomson-Houston machines for 30 arc lamps of 1,200 c.p. each, and one of Elwell and Parker's machines for charging accumulators. There are also two of Willans and Robinson's compound high-speed engines, each of 100 h.p., to drive two Thomson-Houston alternate-current dynamos, each capable of supplying 2,500 incandescent lamps. The current is generated at 2,000 volts, and distributed on the transformer system. The wires outside will not only be insulated on fluid insulators, but will have a quarter of an inch covering of pure indiarubber, and will be placed at a height of 30ft. Hitherto the street lamps have been accessible for cleaning and other purposes only by ladders; but an arrangement has been adopted in the present case by which the lamps can be lowered, and the idea has been improved upon by a very ingenious device of Mr. Orlando V. Thomas, the electrician in charge, whereby the lowering of a lamp entirely cuts off the circuit, so far as it is concerned, and enables it to be handled without risk of danger. This patent automatic device has been invented by Mr. Thomas, and is manufactured by Messrs. Allen and Sons, Tone Foundry, who have invented a winch arrangement, which they have also patented, and will in future combine with Mr. Thomas's invention. The whole of the steam piping, countershafting, and fixing of the engines has been carried out by Messrs. Easton and Waldegrave, engineers, Taunton. The new standards have been manufactured and fitted by Messrs. Allen, another local firm, and Mr. H. J. Spiller has satisfactorily carried out the building contract, the architect being Mr. F. W. Roberts.

Islington.—The Special Committee, of which Mr. H. S. Friend was chairman, appointed the Islington Vestry to enquire into the subject, reported that they had considered the report made by Major F. A. Marindin to the Board of Trade last year, after the enquiry held by him in connection with the applications then made for electric lighting orders, pursuant to the Electric Lighting Act of 1881 and 1882, and found that certain general principles and conclusions were then arrived at, and that a model order in accordance therewith was subsequently approved by the Board. The model order had been carefully copied by the committee with the orders sought to be obtained in Islington during the present session by the Brush Electrical Engineering Company and the House-to-House Electric Light Company, and find that the latter are identical with the former, except in certain matters of detail. The Brush Electrical Engineering Company's order included in its area Hampstead, Shoreditch, St. Pancras, St. Luke.s, Marylebone, Bethnal Green, Whitechapel, Hackney, and Stoke Newington, as well as Islington. The House-to-House Electric Supply Company's order only applied to the parishes of Islington and Hornsey. Neither order made provision for generating stations, and only provided for the deposit of £1,000 each in respect to the areas affected by the orders. Under all the circumstances the committee was of opinion that the two companies should be required to deposit at least £1,000 each in respect of their works in the parish of Islington alone, this being in accordance with the precedent set by the model order, to omit all reference to the County Council in connection with the control of overhead wires and the breaking up of streets in the parish; to schedule, in addition to the streets scheduled by the House-to-House Electric Supply Company, Junction-road and Parkhurst-road, and that, as regarded the Brush Electrical Engineering Company, it be required to omit the clause enabling it, with the sanction of the Board of Trade, to transfer its order. Subject to these requirements being complied with, and to a satisfactory understanding being arrived at with the companies as regarded minor details, the committee recommended that it be authorised to intimate to the respective companies that the formal consent of the Vestry, as the local authority, be given to each of such provisional orders. Mr. Friend moved the adoption of the report. Mr. Rayson was afraid of a monopoly if the two companies amalgamated. He thought at least £2,000 should be deposited. Mr. Chamberlyne moved as an amendment, that it referred to the special committee to serve notices of objections to the Bills upon such points as they might decide, and that the further consideration of the matter be adjourned until next meeting of the Vestry. Mr. Dryden thought that the Vestry themselves ought to undertake the lighting of the parish by means of electricity. If a private company could make a profit out of it, surely the Vestry could do so. They had had quite enough of monopolies in the past. Mr. Friend, who offered no objection to the amendment, suggested that some of the legal members of the Vestry should be added to the committee. The suggestion was adopted and the amendment was carried. The names of several gentlemen were then added to the committee.

HOW TO PRODUCE ELECTRICAL PRESSURE.*

Apparatus.—The apparatus constructed to generate electrical pressure may conveniently be divided into four classes, though the fundamental effect in each case may be taken as chemical:

1. Induction or frictional apparatus.
2. Batteries.
3. Dynamos.
4. Thermo-electric apparatus.

Induction or Frictional.—This was the earliest known apparatus for obtaining electrical phenomena. A piece of amber or a piece of dry glass, a rod of ebonite or of sealing-wax, etc., rubbed with a piece of dry silk will attract small pieces of paper or pith. But a more convenient apparatus than this was first introduced in the latter part of the seventeenth century, which developed into the well-known cylinder and plate-glass machines. Dr. Gilbert, in 1600, in his *De Magnete*, mentions a number of substances having this attractive property, as amber, gagates, diamond, sapphire, carbuncle, iris gemma, glass, hard resin, etc., and Sir Isaac Newton, in 1675, communicated a paper to the Royal Society on the subject. Stephen Gray, in papers commencing with 1720, describes his experiments, which resulted in a kind of electric telegraph, and the better knowledge of conductors and non-conductors. The work of these and a dozen other early experimenters is a fascinating study, especially to those who are interested in the archæology of the telegraph. This class of machine, too, is useful in the study of the inductive circuit. [The cylinder machine is then described.] The best of this class of machine is that of Wimshurst. The ordinary pressure from these machines is about 10,000 volts, but a pressure of 40,000 or 50,000 volts is easily obtained.

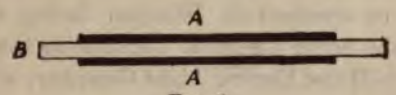


FIG 1.

Leyden Jar and Condenser.—For many experimental purposes an inductive circuit is formed by using a Leyden jar, the conductors on the surfaces of which are placed respectively in conductive connection with the conductor and the rubber of the machine. [A diagram of a Leyden jar is shown—merely a glass vessel coated about three parts up, both inside and outside, with tinfoil.] When charging, the Leyden jar has its exterior coating connected to one pole of the machine, its interior to the other, the glass being the dielectric. It will be seen at once that the same effect is obtained by taking a flat piece of glass, B, Fig. 1, coating it with tinfoil, A_1 A, on both sides, and putting A into contact with one pole, and A_1 with the other. This latter form is termed a condenser, Fig. 1*, but in condensers intended for practical work the dielectric is usually paraffin, and the strips of conductor are more numerous. Thus, by a number of strips of conductor, A, A, A, separated from other strips, A_1, A_1, A_1, by paraffin, all the A strips being connected to a terminal, T, and all the A_1 strips to a terminal, T_1, we decrease the dielectric resistance and increase the accumulation. Condensers of this kind are largely used in duplexing submarine cables. The cable itself is like a long Leyden jar, and in working it acquires a charge, which charge has to be balanced to obtain the conditions necessary for duplex working. Condensers are also used to increase the effect of induction coils.

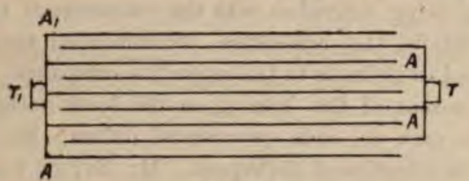


FIG. 1.*

Batteries.—This class of apparatus is due to the investigations of Galvani and Volta. Of the making of batteries there is no end, but of the hundreds that have been devised only *four* or five will be mentioned here. A good battery requires the properties of high electric pressure, constancy, longevity, and low internal resistance. No combination gives more than about two volts pressure, but it is easy to add the pressure of cell to cell so that any required pressure may be obtained. A single combination, such as that shown in Fig. 2, is termed a cell, and a battery is composed of one or more cells.

Contact v. Chemical Theory.—The generation of electrical pressure has been attributed by one school of philosophers to the *contact* of two different metals or substances, and by another school to the *chemical action* of one substance upon another. The controversy seems to us to touch upon the ridiculous, for a little consideration will reduce both contact and chemical to one, and that one is chemical. It is well known that chemical changes are produced in some substances when they come into contact with certain other substances. It is also as well known that the force which causes chemical action is exerted only at insensible distances, and frequently the mere bringing into ordinary contact does not bring the substances within the distance at which chemical action can take place. Further, it may be assumed that the substance, or substances, chemically acted upon undergo a preparatory change before the commencement of the action. At what distance this preparatory change commences is not known, but we hold it probable that it is this preparatory change that gives support to the contact theory. At any rate if contact sets up the pressure, chemical action is required to continue it. From these remarks it will be inferred, and justly so, that the effective pressure obtained depends upon the materials selected in the combination.

The Couple.—A combination or a cell generally consists of two dissimiliar metals immersed in a conducting liquid, which acts chemically upon one of them. The metal acted upon is termed the + or the electro-positive, the other the − or the electro-negative plate. The following is a list of metals, commencing with the most electro-positive when immersed in dilute sulphuric acid. The order may be slightly changed when immersion is in some other electrolyte.

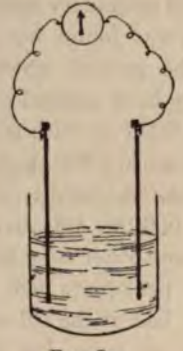


FIG. 2.

FIG. 3.

+ Zinc, tin, lead, iron, nickel, bismuth, antimony, copper, silver −

From these metals the greatest effective pressure in dilute sulphuric acid would be with the couple zinc and silver, but as silver is expensive and very little better than copper, zinc and copper is a couple frequently used.

Those who desire to investigate the relative electrical positions of the various metals and other substances in different electrolytes, will find a very comprehensive account of the whole matter in Dr. D. Tommasi's book on batteries. Perhaps the most thorough investigation on the subject is that by Dr. Gore, of Birmingham, who tabulates the position of some two dozen substances in various solutions at various degrees of concentration and different temperatures.

Constancy.—If a simple combination of zinc and copper in dilute sulphuric acid is taken as in Fig. 2, it will be found when external contact is made that the copper plate is covered with minute bubbles of gas, which increase in size and come rapidly to the surface. If the gas is collected and tested it is found to be hydrogen. Starting then with the couple zinc and copper, as soon as the copper plate is covered with hydrogen we get another couple, zinc and hydrogen, and the tendency of this couple is just the opposite of the original one. Assuming then that the electrical pressure originally acts from Zn to Cu, under the new conditions a reverse pressure is set up from hydrogen (H) to zinc (Zn). This is smaller than the original, and the result is an electrical pressure from Zn to Cu, but diminished by the counter pressure H to Zn. It will at once be seen that constancy cannot be obtained by a combination of this kind, so many attempts have been made to add something to the original combination that should combine with the hydrogen, keeping the copper plate clear and interfering no further with the electrical action, and thus be enabled to get a constant electrical pressure, which would, of course, through a constant resistance give a constant current. Prof. Daniell was the first to solve the difficulty, and the battery known as Daniell's will now be described.

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* *Extracts from "First Principles of Electrical Engineering."*

Daniell's Battery.—A Daniell's battery is generally constructed of an outer case of copper, C, a porous earthenware pot, D, and a rod of zinc, Z. Binding screws for fastening the external conductors are fixed to the zinc and copper. The zinc rod is amalgamated; for ordinary commercial zinc, when used as the active plate of a battery couple, is liable to be uselessly wasted when not required by local action, due to couples arising between the zinc and the impurities it contains. To prevent this local action, the zinc is amalgamated by being first cleaned with sulphuric or by hydrochloric acid and then rubbed with mercury. The mercury forms an amalgam with the zinc, which, so far as electrical action is concerned, has all the properties of pure zinc at a much less cost. The mercury can be rubbed on the zinc by means of a clean rag. The amalgamated zinc is placed in the porous pot, which is then nearly filled with dilute sulphuric acid, one part acid to eight of water. The outer jar is nearly filled with a solution of sulphate of copper. A perforated ledge, T, or a kind of perforated pocket in the outer jar, permits a quantity of the sulphate of copper to be kept in the cell so as always to have a saturated solution. The action is somewhat as follows:

$$\begin{array}{ccccccccc} \mathrm{Cu} & & & & \mathrm{Zn} & & & & \mathrm{Cu} \\ \Big| & \mathrm{CuSO_4} & \Big| & \mathrm{H_2SO_4} & \Big\| & \mathrm{H_2SO_4} & \Big| & \mathrm{CuSO_4} & \Big| \end{array}$$

The sulphuric acid in contact with the zinc plate is decomposed, forming sulphate of zinc ($ZnSO_4$), the H_2 liberated decomposes the sulphate of copper ($CuSO_4$), forming H_2SO_4, setting free Cu, which is deposited upon the copper plate. Thus the copper plate is always kept clean. The conditions before and after the circuit is closed is thus shown:

Before	Cu	$CuSO_4$	H_2SO_4	Zn
	Copper.	Sulphate of Copper.	Sulphuric Acid.	Zinc.
After	Cu Cu	SO_4H_2	SO_4Zn	
	Copper on Copper.	Sulphuric Acid.	Sulphate of Zinc.	

Grove's Battery.—A modification of Daniell's battery is that of Grove, wherein nitric acid takes the place of sulphate of copper, and a platinum plate that of the copper plate. The action may be shown thus:

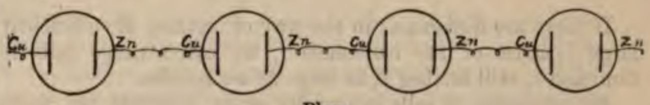
Before closing circuit				
	Pt	N_2O_5	H_2SO_4	Zn
	Platinum.	Nitric Acid.	Sulphuric Acid.	Zinc.
After				
	Pt	N_2O_4	OH_2	SO_4 Zn
	Platinum.	Nitrous Acid.	Water.	Sulphate of Zinc.

The Bunsen battery is similar to Grove's, except that a carbon plate is substituted for platinum.

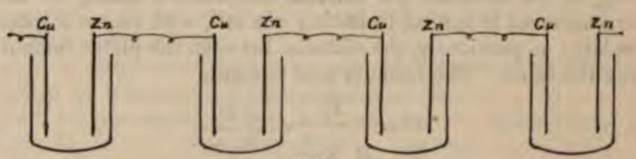
The Leclanché Battery.—This battery is not so constant as the others mentioned, but it is largely used for such purposes as electric bell work, where intermittent currents are wanted, and although it rapidly polarises on closing the circuit, it soon recovers its full electrical pressure. Another good feature about this battery is that it is less liable to local action than the Daniell and many others. In it the zinc plate is put into a solution of salammoniac, while the carbon plate is surrounded with crushed binoxide of manganese. The action may be indicated

Before	C	$2MnO_2$		$2NH_4Cl$	Zn
	Carbon.	Binoxide of Manganese.		Salammoniac.	Zinc.
After	C	Mn_2O_3	H_2O	$2NH_3$	$ZnCl_2$
	Carbon.	Sesquioxide of Manganese.	Water.	Ammonia.	Chloride of Zinc.

Secondary Batteries.—The batteries hitherto mentioned and scores of similiar batteries are called primary batteries, in contradistinction to another class that has lately been developed for practical use, termed secondary batteries. In primary batteries the materials when once used have to be renewed. In secondary batteries, on the contrary, the materials can be renovated and used over and over again. If we take a couple consisting of two lead plates in dilute sulphuric acid, and place the couple in a conductive circuit as in Fig. 3, one of the lead plates becomes coated with a thin coating of lead peroxide. If now this cell is taken out of the circuit and placed in a circuit of its own, of which it forms the source, on completing the external circuit, a current passes in the external circuit from the oxidised plate to the other plate. The cells then are reversible. A current passed through them produces certain chemical changes. The sending of the current through the cells is called charging. When the cells are discharged they form the source of the electrical pressure and current. During discharge reverse chemical changes take place, the combination thus regaining its original state. In practice, however, they are only partially discharged and then recharged. By using lead plates alone only a comparatively small effect can for a long time be obtained, the plates getting better and better after numerous chargings and dischargings till the plate that is oxidised becomes thoroughly porous, and offers a very large surface to the action of the electrolyte. To save the time and cost of "making plates," that is, getting thoroughly porous plates, numerous devices have been put forward till the best of the modern secondary batteries consists of a "grid," which is cast of an alloy of lead and antimony. The holes in the grid taper outwards. The plates intended for positives are filled up with a paste made of red lead and sulphuric acid, the negatives being filled with a paste of litharge and sulphuric acid. The exact chemical changes that takes place in charging and discharging these lead reversible batteries is not definitely settled. M. St. Drzewiecki believes the positive plate after charge to be coated with a combination having the formula $H_2Pb_2O_7$, and this after in discharge is reduced to PbO_2. The negative plate after charge consists of lead hydrate $2 \cdot \overset{\cdot}{H}$ Pb, and after discharge of a mixture of hyposulphate and sulphate of lead.



Plan.



Section.

Fig. 4.

Longevity.—The length of life of a battery depends upon the work it has to do, the attention paid to it, and the amount of local action that takes place. With regard to secondary batteries, there is really no trustworty data to enable a correct judgment to be formed. With careful attention ten years should be a short life for this class of battery.

Internal Resistance.—The internal resistance of a cell depends upon the surface area of the opposed plates, the electrolyte used, the condition of the electrolyte, the quality of the porous pot, and the distances between the plates.

Arrangement of Batteries.—The battery must be selected and arranged with due consideration for the work it has to do. In the first place, it is necessary to have sufficient electrical pressure to overcome the resistance in the circuit. This resistance may be divided into two parts, one external to the battery, the other the internal resistance of the battery itself. Hence we may write Ohm's formula

$$C = \frac{E}{R + r}.$$

When $R =$ the external resistance, and r the internal resistance. To obtain the desired pressure, cells are connected in series as in Fig. 4. If n cells are placed in series, then the electrical pressure, E, is increased n times, and the internal resistance is also increased n times. The formula then becomes

$$C = \frac{n\,E}{R + n\,r}.$$

The available pressure for use in the external circuit is not increased n times, but something less, considerably less if the internal resistance is large. Thus, we have one reason for keeping the internal resistance as low as possible—viz., that as much available pressure as possible shall be had for use in the external part of the circuit. When the external resistance, R, is very small, as when the poles are joined by a short, thick, good conductor, and can be neglected, the above formula becomes

$$C = \frac{n\,E}{n\,r},$$

little of the current developed by the pressure is then practically utilisable. When R is so small that nearly the whole current goes through the internal part of the circuit, the battery is said to be short-circuited.

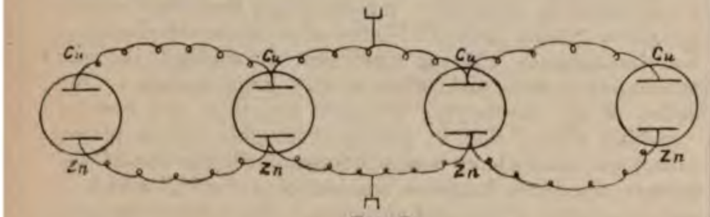


Fig. 5.

If there are difficulties in the way of getting E sufficiently large because of the resistance r, we can arrange cells to diminish r, still having E as large as we require.

By arranging n cells in parallel or in multiple arc, as in Fig. 5, we decrease the internal resistance n times, for the arrangement is similar to having one cell, with plates n times as large as previously, the distance between the plates remaining the same. The formula now becomes

$$C = \frac{E}{R + \frac{r}{n}} = \frac{n\,E}{n\,R + r}.$$

If r is small compared with $n\,R$ it may be neglected, and we again get

$$C = \frac{n\,E}{n\,R} = \frac{E}{R},$$

that is, the available pressure is almost all used in the external circuit when r is small. Figs. 6 and 7 show two ways

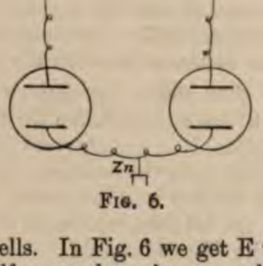


Fig. 6.

of arranging six cells. In Fig. 6 we get E three times that of one cell, and r half as much as in one cell. In Fig. 7 E is twice that of one cell, and r is one-third of that of one cell. Such arrangements are called multiple series arrangements. Thus, we have three ways of arranging cells in batteries—in series, in multiple arc, or in multiple series. The formula *put into figures*—say, for 6 cells of 2 volts each, with internal *resistance ·5 ohm, and say $R=12$ ohms,* become

1. In series :

$$C = \frac{n\,E}{R + nr}$$

$$C = \frac{6 \times 2}{12 + (6 \times {\cdot}5)} = \frac{12}{15} = {\cdot}8 \text{ ampere.}$$

2. In multiple arc :

$$C = \frac{E}{R + \frac{r}{n}} = \frac{2}{12 + \frac{\cdot 5}{6}} = {\cdot}16 \text{ ampere (about).}$$

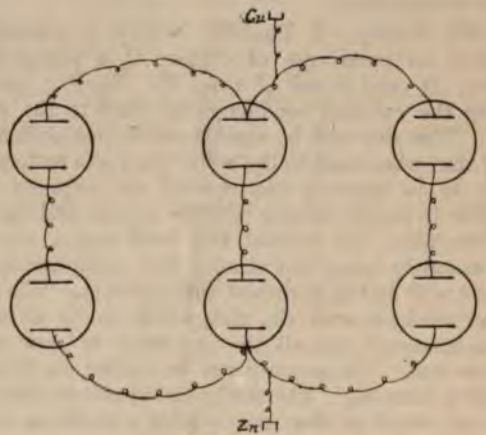


Fig. 7.

3. In multiple series as in Fig. 6 :

$$C = \frac{\frac{n}{2} \times E}{R + \frac{r}{2}} = \frac{3 \times 2}{12 + {\cdot}25} = \frac{6}{12{\cdot}25} = {\cdot}49 \text{ ampere.}$$

4. In multiple series as in Fig. 7 :

$$C = \frac{\frac{n}{3} \times E}{R + \frac{r}{3}} = \frac{2 \times 2}{12 + {\cdot}16} = \frac{4}{12{\cdot}16} = {\cdot}33 \text{ (about)}$$

(To be continued.)

TEMPERED COPPER FOR ELECTRICAL WORK.

BY GEO. H. BLISS.

My attention was called some time since to the claims of the Eureka Tempered Copper Company, of North East, Pa. Considering the subject novel and of great importance to the electrical art, I arranged, on a recent Eastern trip, to pay a visit to the above-named establishment.

North East is a small town in the Pan Handle of Pennsylvania, situated on Lake Erie, and through which the Lake Shore road runs, so that it is not a difficult point to reach, as might be first supposed.

It has some natural advantages for the business, and being the home of Mr. Alfred Short, the president of the company, and near to Erie, Pa., which is the residence of the Hon. W. L. Scott, who is largely interested in the enterprise, was finally chosen as the headquarters for the business.

I am quite sure that anyone interested in electrical industries and who has the opportunity will feel well repaid for stopping at North East to investigate this matter, and will find Mr. Short ever ready to make fully understood the many valuable uses to which tempered copper can be applied.

The business is new, but it has already outgrown the early quarters provided, and substantial brick buildings of considerable extent are being erected, so that a rapidly growing trade can be handled with promptness and success.

It is a general belief that the ancient nations, both in the old and the new world, possessed knowledge which enabled them to temper copper, and they are known to have used it for edged tools. Samples of these tools have been found in many places, but I believe that an analysis of the materials of which they were composed reveals in all cases the presence of alloys, and, while such tools have been hardened in a degree, it is evident that there exists a wide difference between the method of the ancients and the modern process.

Mr. Almer Thomas, who devised the present process of tempering copper, is therefore something more than a rediscoverer, for he is the inventor of a new means for tempering copper without the aid of alloys.

The importance of this fact is well understood among electricians, for any alloy in copper decreases its conductivity and diminishes the value for electrical uses.

I regret not having on hand a table showing the results of a large number of electrical measurements upon samples of tempered copper, but it has been conclusively demonstrated that the modern tempering process does not injure in the slightest degree the conductivity of the copper.

The following analysis of several samples of tempered copper were made by Dr. F. A. Genth, of Philadelphia, Pa., Nov. 1, 1889. The figures show conclusively that foreign materials are not introduced in tempering the copper, and that it remains in a pure state.

	1. Pig copper.	2. Edge pieces.	3. Castings.
Silver	0·096	0·053	0·095
Copper	99·890	99·961	99·914
Tin	trace	0·045	0·094
Lead	,,	trace	trace
Iron	0·056	0·069	0·056
	100·042	100·128	100·159

The value of tempered copper in connection with heavy machinery where large weights must be sustained depends upon its ability to resist compression.

The following compression tests made by the Brooks Locomotive Works, Dunkirk, N.Y., May 24, 1889, indicates the remarkable value of tempered copper in the mechanic arts, where pure copper heretofore has not been available :

TABLE I.—TEMPERED COPPER IN COMPRESSION.

No. 2 80,000 pounds load.	Diameter ·961in. Total length.	Length 1·83in. Pounds load.	Area ·722in. Total length.
0	1·830	60,000	1·120
2,000	1·825	64,000	1·080
4,000	1 815	68,000	1·025
6,000	1·815	72,000	·980
8,000	1·800	76,000	·945
10,000	1·795	80,000	·900
12,000	1·770	..	..
14.000	1·770	...	...
16'000	1·740	...	...
18,000	1·720	...	...
20,000	1.690	...	...
22,000	1·665	...	...
24,000	1·640	...	...
26,000	1·606	...	...
28,000	1·585	..	...
30 000	1·545	...	...
32,000	1·520	...	...
34,000	1·495	...	...
36,000	1·462	...	...
38,000	1·430	...	...
40,000	1·400	...	...
42,000	1·375	...	...
44.000	1·335	..	..
46.000	1 310	..	...
48,000	1·280	..	...
50,000	1·255	...	...
52,000	1·235	...	...
56,000	1·170	...	...

NOTE.—The 80,000lb. above corresponds to 110,803lb. per square inch. Measurement of deflection taken roughly with ordinary calipers.

Still more valuable to the electrical fraternity are the tests made by the same parties and at the same time and place, showing the great tensile strength of pure copper, as shown in Table II.

By the Thomas process copper is tempered to almost any degree of hardness. Its tensile strength is easily made four or five times that of pure copper and much superior to hard drawn copper. Its utility for overhead electrical conductors, where strength and high conductivity must be had, is superior to that of copper in any other form.

TABLE II.

TEMPERED COPPER IN TENSION.

Pounds load.	Diam. ·797in. Lbs. load to sq. in.	Length 3in. Total length, inches.	Area 50in. Total elongetion.
0	0	3,000	0
1,000	2,000	3,000	slight
2,000	4,000	3,000	do.
3,000	6,000	3,000	do.
4,000	8,000	3,000	do.
5,000	10,000	3,005	·005
6,000	12,000	3,015	·015
7,000	14,000	3,040	·040
8,000	16,000	3,075	·075
9,000	18,000	3,110	·110
10,000	20,000	3,140	·140
11,000	22,000	3,195	·195
12,000	24,000	3,250	·250
13,000	26,000	3,320	·320
14,000	28,000	3,400	·400
15,000	30,000	3,510	·510

15,220lb., breaking load.
Tensile strength, per square inch, 30,440lb.
Breaking stress, per square inch, 30,440lb.
Elastic limit (approximated), 9,000lb.
Total elongation, 17 per cent.

Alloys of all kinds make copper brittle, whereas tempered copper becomes so tough that four sharp kinks are required to break it, while one is sufficient to break ordinary copper.

Many of the *Electrical World* readers are familiar with the fact that it has heretofore been impossible to make perfect castings of pure copper. The process devised by Mr. Thomas overcomes this difficulty, and the Eureka Tempered Copper Company furnish pure copper castings of any desired dimensions. These castings are tempered when required to any degree of hardness.

It is a well-known fact that alloyed copper is quickly attacked by alkali, salt water, and mercury.

Pure copper is much less affected, and it is, therefore, practicable to use tempered copper in the form of castings, sheets, and wire in many places where alloyed copper is not available. Few of us ever supposed that copper would be used for springs, and yet this is practicable and desirable, when tempered, for many applications. It is amusing and surprising to listen to the clear ring of a bell made from pure tempered copper, but this is one of its uses.

The merits of tempered copper have been quickly recognised by many in the electrical fraternity, and already such companies as the Edison, Thomson-Houston, and Westinghouse, who are anxious to supply their customers with the best machinery, are using it to a considerable extent. Its superiority over drop forged castings for commutators and many purposes is readily apparent.

Drop forged castings necessarily have greater electrical resistances than pure copper. Pure copper, properly tempered, when used in commutators, will outlast four or five ordinary commutators, as has been demonstrated by experience.

Tempered copper, when used for gear wheels for electric motors, is noiseless and outlasts anything else. It is next to impossible to break or twist off a tooth in a tempered copper gear wheel.

The great advantages of tempered copper for journals has been amply demonstrated. Locomotives have run thousands of miles with journals of this material without heating, and with little wear. It has been applied to journals where the speed is 7,500 revolutions per minute with success.

Little oil is required upon the journals where it is used, and the economy in attention and repairs is considerable. The uses to which tempered copper can be applied are multiplying daily and seem to be held in check only by the considerable cost of the article.

To those in the electrical profession who have not given the subject attention, it is worthy of early consideration. No one can investigate it without being convinced that its extended use will greatly increase the efficiency, reliability, and durability in every branch of electrical construction.—*Electrical World* (New York).

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THE LAW OF INVERSE SQUARES.

"More haste less speed." Yes, we were rather too soon in congratulating Prof. Silvanus Thompson upon his attitude in relation to the law of inverse squares. We never intended to suggest the law of inverse squares did not hold good in certain hypothetical cases which have no existence either in the heavens above, or on the earth beneath, or in the waters under the earth. So far as regards practical electrical and magnetical problems, the law is as useless as the laws of the Medes and Persians. That is, the law exists, only in a state which is non-existent. Prof. Thompson in reiterating the truth of the law of inverse squares as applied to mathematical points—mind, not physical points—referred to a controversy with Brudenell Carter in connection with colour, again, on the question of inverse squares. We have nothing whatever to do with the application of the law to the loss of colour by distance, and only mention the reference to repudiate its application to us. The matter, so far as it relates to electricity and magnetism, may be put plainly and simply. The law of inverse squares holds good as a mental gymnastic exercise of the mathematicians ; it holds good nowhere else, and for nothing else where magnets are concerned. Never yet was magnet constructed with poles consisting of mathematical points only, nor with poles an infinite distance apart. It is rather ingenuous to suggest that an opponent does not understand the subject under discussion, but that is not argument, nor is it proof of the statement. The rapid change of front that can be assumed by mathematicians, the ease with which they can add or subtract a term, making an expression fit any case presented to them, makes it exceedingly difficult to pin them down to a particular corner.

In the case under consideration, Prof. Thompson agrees that the "law of inverse squares" only applies to a magnet having mathematical points as poles, and poles far enough apart not to interfere with each other. His lectures purported to be directed to the full discovery for the use of practical men of how to arrive at the dimensions and designs of electromagnets for all purposes. As a rule, speakers and writers lug in this law of inverse squares for the benefit of practical men, as one of the data for further calculation. Prof. Thompson, we understood, gave it up, and we congratulated him accordingly. However, now he says he does not give it up, that it is true when it is true, and it applies just to those cases to which it does apply—a soft impeachment which nobody can deny. Our congratulations, however, hold good so far that the "law of inverse squares" does not apply to any magnet constructed for show or for use in mechanism, only for the ideal thing that doesn't exist.

Enough for this particular topic. It is chosen simply to point a moral. If it is once admitted that a theoretical formula as deduced by mathematicians can have no practical value in the hands of those who apply science, the sanctity of the high priesthood of professordom will be scorned. Three-fourths of the formulæ taught in the schools are useless in every sense of the term, but especially so if it is recollected that life is short, that the purpose of acquiring knowledge is to use it, and therefore if half a student's time is wasted upon the study of theoretics that will be proved to him hereafter to have no existence in practice, the sooner the system is abolished the better. Instead of assisting towards simplification, the professorate, as a whole, assist toward complication, and they stick to their guns with as much persistency as if they deemed themselves and their knowledge infallible. They cram their books and their teaching with units, notation, and nomenclature that drives the plain matter-of-fact Englishman crazy. Instead of directing their energies to ease the labours of those who have to apply science, they compel the latter to waste valuable time in learning what, when they come to practical work, they are only too glad to unlearn as quickly as possible. It is Prof. Thompson's seeming inclination to throw aside the trammels of pedagogy that causes us to look upon him somewhat in the light of a reformer. Candidly, our view of a professor's duty is, from the point of the transcendentalist, a low one. If he is professor of a science which has its corresponding art, his duty is clear, and it is to enable his pupils to specify a particular machine to do particular work. Vague generalities are rubbish, theoretical disquisitions are verbiage. If the professor of electricity cannot teach his pupils to design a dynamo, or a motor, or any other piece of apparatus, giving the exact or approximately exact dimensions of the various parts of the machine, the professor is not worth wasting words about. He is more than useless; he fills the place of a better man. Now tried by this touchstone, where are our professors? Is it their pupils that are found in the big works designing machines? "By their works ye shall know them" applies as much here as to moral questions. Well, we don't know them by their works, with exceptions that can be counted upon the fingers of one hand. The argument that professors are to teach principles, not trades, is a specious one, and intended to hide their inutility. Men are not born to suck their thumbs all their lives. They require knowledge to use it, and if it is useless, so much the worse all round. The teaching of principles means simply the man cannot himself apply his principles, and yet he is content to believe his pupil will be able to apply them. The general principles involved in the whole of the physical sciences are not worth more than half a year's study, and if a man is to generalise longer than this it only is to muddle his brain with useless pabulum.

Prof. Thompson is the first professor we ever heard get up and deliberately tell his audience that he would put them in the way of making a special piece of apparatus to specification. That alone was a step in the right direction. The substance of his lectures also fairly fulfilled his promise, but yet he has a long way to go before he reaches the point where we sooner prefer to see him. It would be well here to suggest an addition to his manuscript, if, indeed, the addition we suggest be not there already as a part of what time would not allow him to speak Take half-a-dozen special cases, and give the exact dimensions of parts. So doing will make the Cantor lectures of 1890 intensely practical, and conclusively prove that the lecturer was not a mere dealer in generalities, but knew exactly what his words meant.

We cannot conclude this article without giving an example of a professor's questions: 1. Give a clear sketch of the theory of magnetic fluids? In our opinion any professor who troubles his students for more than ten minutes about theories of magnetic fluids ought first to find the elixir to extend the term of natural life a hundredfold, and student's life accordingly. This question is followed by another asking to show that the relative strengths of two poles are as 2 : 3, because one requires a pull of 4oz. and the other a pull of 9oz. to release a ball of soft iron from one pole of each of the magnets respectively. These magnet poles are not points, and yet the professor applies the law of "inverse squares." Again we hope to count Prof. Thompson on our side against such examinational questions as these.

CORRESPONDENCE.

COAD'S BATTERY AND MINERS' LAMP.

To THE EDITOR OF THE ELECTRICAL ENGINEER.

SIR,—Allow me to thank you for your notice of my exhibition of primary battery and miner's portable lamp in your last issue.

There are one or two corrections I desire to make.

The fluid is stated to be a secret process, and doubt is thrown upon the cost. Anticipating this, I had instructed Prof. Redwood to certify the cost of fluid, the process for which is provisionally protected, and his report will be publicly advertised in your next issue.

The cost, therefore, of fluid and consumption of zinc for the shift of eight hours in the miner's lamp, weighing under 5lb., will then be verified; it certainly will be under twopence.

The lamp your correspondent saw was not, as he stated, an overrun one of 2 c.p., but is made in three sizes—namely, ⅔, 1½, and 2 c.p.; and the appearance of being overrun proceeded from its being seen through the lens, which I claim increases nominal candle-power by 2,000 per cent., verified by Alex. Wright and Co.'s report.

I am sure your well-known unbiassed attitude towards workers in electrical advance will induce you to give publicity in justice to,—Yours, etc.,

THEOPHILUS COAD.

[Further particulars are given in an advertisement in another column. As we have said, we shall be glad to welcome any battery which proves itself to be—as this seems to give some promise of being—a practical commercial article.—Ed. *E.E.*]

LITERATURE.

A Guide for the Electric Testing of Telegraph Cables. By Col. V. Hoskiær. Third edition. E. and F. N. Spon, London.

There is no application of electricity that requires such continuous, careful, and delicate tests as cables. The peculiarities of cable work lead to the closest attention being given to every portion of a cable. The conductor has to be of specified purity, because it was found that slight impurities frequently found in commercial copper were detrimental to its conductivity. Absolute purity is, perhaps, unattainable, but we suppose, taken on the whole, the copper used in cable work is about as pure as it can be made. It was the necessities of cable work that directed attention to charge, and ultimately gave us the Taylor-Muirhead condensers used in duplexing. F. C. Webb, about the year 1863, wrote a good deal on the subject of charge, accumulation, etc., whilst Willoughby Smith and others directed their efforts to the providing of a thoroughly reliable insulation suitable for water at all ordinary temperatures. Then for this purpose was fought the fight between guttapercha and indiarubber, in which guttapercha triumphed, and has held its position for cable insulation ever since. The depredations of the "teredo" and its compeers led to Johnson and Phillips designing the "tape" protection now so largely used for cables in warm waters.

From the start to the finish of the construction and laying of a cable it is subject to continuous tests, and the purpose of this book is to describe these tests and how to perform them. The tests are considered under five divisions, relating respectively to conductivity, charge, insulation, insulation of joints, and the position and magnitude of a fault. The tests are the ordinary well-known tests, about which there is nothing new to be said. They are described clearly with numerical examples. The only suggestion we should make would be the advisability of putting the diagrams with the letterpress instead of collecting them at the end. Nothing can be more annoying to the student than to have to look at a line of explanation and then turn over 50 or 60 pages to the diagram.

With the extension of electric lighting the necessity for testing will increase. Faults will occur in cables, and these will have to be found, not by rule of thumb, but by more scientific methods, and testing will have to be continuous during manufacture. Here large currents are dealt with, and faulty insulation will soon cause trouble. Hence engineers will have to make themselves acquainted with the subject of testing.

Lecons sur L'Electricite (Electrostatique, Pile, Electricite Atmospherique) Faites a la Sorbonne en 1888-89. Par H. Pellat. Rédigées par J. Blondin. Paris, Georges Carré: 1890.

At the present juncture quite a plethora of books is issuing from the press of our neighbours across the Channel. Recently we noticed a goodly-sized volume due to M. Hospitalier, now we have one devoted to the consideration of another portion of the many electrical subjects. This book is intended more directly for students. It appeals to them rather than to those who have to do with the manufacture and use of apparatus applying electricity to daily wants. The practical applications of statical electrical apparatus are few, and one feels that, though of great interest, at present the object of the study of atmospheric electricity is to know something about lightning-rods. The time may come when new discoveries will be made, enabling us to increase the "applied science" section of electrostatics. Till then it is the duty of every student to make himself familiar with what has been done, and attempt to look further into the unknown for the benefit of his fellow-men. Lectures and books like this consolidate the subject, and although the arguments are based on the usual scholastic lines, in which mathematics are often made to fit exact knowledge, rather than await it or carry out more experiments to fit exact knowledge, this mental gymnastic exercise is not useless, for with every new departure the mathematician has only to add to or subtract from his formula to get a result up to date. This work of MM. Pellat and Blondin is a good book of its kind, and will be useful, as we say, to those whose object is the advance of pure science.

THE THEORY OF ARMATURE REACTIONS IN DYNAMOS AND MOTORS.*

BY JAMES SWINBURNE.

It seems to be generally supposed that electrical engineers are in full possession of means for calculating out and designing a dynamo or motor. This is no doubt the case as regards very small machines, and as regards large machines when considered with reference to no load. The effect of the armature current is mentioned in the classical paper of Drs. J. and E. Hopkinson, the excitation necessary at full load being given in terms of the armature current-turns and the lead of the brushes; but as the lead of the brushes is determined after the machine is made, that paper gives the first step towards a solution of the armature reaction, but does not go further. As not only the excitation necessary at full load, but also the best dimensions of the magnets and the proper shape of the pole-pieces, depend on the armature reactions, and as the armature reactions are of immense importance in large machines, such machines cannot be designed with accuracy unless the armature reactions and position of the brushes at full load can be foretold. The armature reactions are often regarded as obscure and unimportant phenomena, but, except in very small dynamos, the error due to neglecting them would be much greater than that due to neglecting the waste field, which has of late received so much more attention.

As most engineers are now in the habit of using C.G.S. measure, the C.G.S. system will be used in this paper. The only new importation into dynamo work will be the idea of magnetic potential, as it is exceedingly convenient for explanation. The magnetic potential is, of course, the line integral of the magnetic force, and is 4π times the current-turns. As it is cyclic, we must take the line integral once round a circuit interlinked with the exciting circuit. Any point of the circuit may be assumed as of zero magnetic potential, but generally difference of potential is alone considered. The magnetic potential may be thought of as ampere-turns, or might be measured in ampere-turns; but as such a method is unusual, it will be taken in C.G.S. measure, being denoted by the symbol Ω; and, for want of a unit of its own, it may be measured in ergs. An ampere-turn thus gives a magnetic potential of $4\pi/10$ ergs, or 1·26 ergs.

MAGNETS AND WINDING.

As single-magnet machines are very largely used now, and a type can be taken which is approximately that used by most of the large representative makers, such a machine may be taken as an example. A formula which gives the size of iron, and the excitation needed, will then be worked out.

The vertical line through the centre may be taken as at zero magnetic potential at no load. Assuming the length of the core to be the same as that of the pole-pieces, and calling the external radius of the core r, and the radial depth of the discs b, and the length of core a, and the armature induction B_a, the surface integral of the induction, or what may be for shortness called the total armature induction, is $2\,a\,b\,B_a$. The desired armature induction is here assumed. In practice different makers prefer different inductions, and to discuss the various considerations would take too much room, and would be outside the subject of this paper. The distance, l_a, which represents the length of iron that has to be magnetised to the induction, B_a, depends on the arc of embrace of the pole-pieces; but a large error in the estimate of this length causes a very small error in the design of the machine, as very little of the excitation is spent on this part of the magnetic circuit. The fall of magnetic potential over $\frac{1}{2} l_a$ is $\frac{1}{2} l_a B_a/\mu$, and may be written $\frac{1}{2} \Omega_a$. The induction in the air gap depends on the armature induction, the radial depth of the discs, and the pole face angle. It will be written B_g. The line integral of the induction across the gap is $\frac{1}{2}g\, B_g$, where g is the distance across the gaps. $\frac{1}{2}g\, B_g$ may be written $\frac{1}{2} \Omega_g$. The fall of potential from the middle of the yoke to the pole-piece depends on the length of the circuit and the induction. It may be written $\frac{1}{2} l_m B_m/\mu$, or $\frac{1}{2} \Omega_m$. The induction that can best be used in the field-magnets depends, again, on many things that cannot be discussed shortly. As it is generally best to use a lower induction in the yoke, that must, of course, be taken into account. As the other half of the magnetic circuit is similar at no load, the line integral of the magnetic force needed in the shunt is $\Omega_s = \Omega_a + \Omega_g + \Omega_m$. As to the length of the field-magnets, it depends on the total excitation needed. Different makers allow different lengths per 1,000 ampere-turns on the fields.

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* Paper read before the Institution of Electrical Engineers.

At full load the armature induction has to be increased to allow for the resistance of the armature and series coils, and sometimes for the leads also. A higher value is therefore taken for B_a, and therefore for Ω_a. The effect of the armature current itself may be divided into two components; and in the case of a drum armature, which may be taken for the sake of simplicity, the electrical effect is the same as if the external conductors were connected across the ends, as shown in Fig. 1. There is thus a belt of current-turns opposing the field excitation, and another belt acting at right angles to it. These may be called the back and the cross ampere-turns, and the induction produced by them, the back and the cross induction respectively. The breadth of these belts, or the number of turns in each, depends on the lead of the brushes. For the present the lead of the brushes may be assumed. The extra difference of magnetic potential between the pole-pieces due to the back current-turns is $\pi C n_b/10$, where C is the armature current in amperes, and n_b the number of external armature conductors in the belt of back turns, n_a being the number of external armature conductors. This may be written—

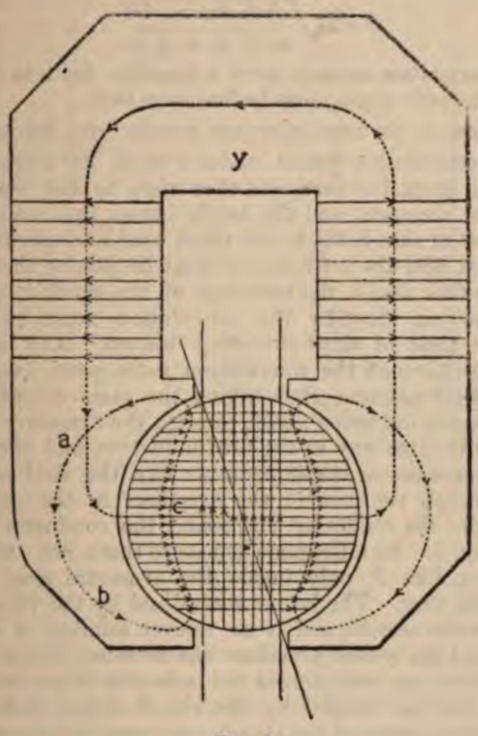

FIG. 1.

$$\Omega_b = \pi C n_b/10 \quad . \quad . \quad . \quad . \quad . \quad (1)$$

The difference of potential of the pole-pieces at full load is thus $\Omega_a + \Omega_b + \Omega_g$; and Ω_a and Ω_g are greater than at no load, because the armature and gap induction are higher. The difference of potential between the pole-pieces may be shortly written, Ω_p. In a given type of dynamo the percentage of waste field varies directly as the difference of potential of the pole-pieces, provided the field-magnets are not strongly magnetised, and is independent of the linear dimensions. The actual waste field, however, varies directly as the difference of magnetic potential between the pole-pieces, and directly as the linear dimensions, or as the diameter of the armature. If the armature cross-sectional area is $2\,a\,b$, and the armature induction is B_a, and if the field induction desired is B_m, the cross-section of the field-magnets must be

$$A_m = 2\,a\,b\,\frac{B_a}{B_m} + \frac{r\,\Omega_p}{M\,B_m} \quad . \quad . \quad . \quad . \quad (2)$$

where M is a coefficient depending on the type of the machine. This coefficient can be readily determined from another machine of the same type but of different size, and an error in its estimation makes comparatively little difference in the dynamo.

In ordinary single-magnet machines M is generally about ·08 to ·085; in double-magnet machines it is less. Of course a great deal depends on the mounting of the dynamo. A machine let into a bed-plate, as is often necessary in the case of direct-coupled engines, has more leakage.

An equation for the shunt and series excitation is now to be found. From (1) the field induction is found—

$$B_m = \frac{2\,a\,b\,B_a}{A_m} + \frac{r\,\Omega_p}{M\,A_m} \quad . \quad . \quad . \quad (3)$$

Giving the value of B_a and Ω_p at no load, the value of B_m at no load is obtained. The shunt excitation is thus

$$= l_a B_a/\mu_a + g\,B_g + l_m B_m/\mu_m \quad . \quad . \quad . \quad (4)$$

in ergs, or this number divided by 1·26 in ampere-turns. By giving the full load values of B_a and Ω_p the total excitation,

$$\Omega_s +{}_m = l_a B_a/\mu_a + \pi\,C\,n_b/10 + g\,B_g + l_m^1 B_m/\mu \quad . \quad (5)$$

is obtained, and, of course, the difference gives the series excitation. Of course the full-load field induction has already been assumed in finding the size of the magnets.

It must not be forgotten that all this time it has been assumed that the lead of the brushes, and therefore Ω_b, is known.

Returning to Fig. 1, a closed line, $a\,b\,c$, may be drawn which is interlinked with all the armature conductors under the pole-piece. The magnetic potential round this circuit is

$$\Omega_c = \theta\,n\,C/10 \quad . \quad . \quad . \quad . \quad . \quad (6)$$

where n is the number of armature conductors, and C is the armature current as before, and θ is the angle of embrace of the pole-piece. As the permeability of the iron, both in the part of the armature and of the pole-piece through which this line passes, is great, the whole difference of potential may be taken as being between the core and pole-piece. The induction under the leading corner, due to cross current-turns only, is then $-\frac{n\,C\,\theta}{2g \times 10}$, and under the trailing corner it is $\times \frac{n\,C\,\theta}{2g \times 10}$. The field is thus weakened under one corner, and, provided the permeability of the iron is practically infinite, equally strengthened under the other, being at its normal value half-way down. The cross induction has in this case no direct effect in increasing or lessening the E.M.F. of the machine. If a dynamo were enlarged to scale, the field excitation would increase as the linear dimensions, but the armature current-turns, assuming the same current density, would increase as the square of the linear dimensions. If the E.M.F. of the machine were kept the same, they would increase faster, as the insulation would take proportionally less room. It is thus evident that a size would soon be reached when the cross induction under the leading corner would be equal to the normal induction due to the field excitation, and there would be no field to reverse the current in the section being commutated. The size at which this takes place varies according to the practice of makers, and is generally above the sizes in common use, as the output of a given armature is generally much smaller than might be taken from it. Machines with single magnets, and fairly large outputs for the size of their armatures, become difficult to design when they have armatures above 35 to 40 cm. diameter. The fault can to some extent be corrected in single-magnet machines by making the polar angle—that is, the area of the pole face—small, There are then fewer cross current-turns, and the induction in the gap is greater, so there is less chance of reversal of induction under the leading corners. This demands more field excitation and larger field-magnets, as the difference of magnetic potential between the poles is greater, and so the waste field is greater. If the pole-pieces are made small, so as just to carry the induction due to the field-coils without saturation, one side will be to some extent saturated by the additional induction due to the cross current turns. In Fig. 2 the pole-piece is small across $a-b$, and the iron may need some magnetic force there so the whole of the magnetic force of the cross current-turns will not be spent on the gaps, and the cross induction will thus be less. On the other side, of course, the cross induction is not lessened, as the iron is less magnetised. The resulting field will not be symmetrical. If the armature is Gramme-wound, the lower brush will need more lead than the upper. Sparking at the lower brush in single-magnet Gramme machines has been frequently noticed by dynamo makers. Of course it may be partly due to the poles being too small in section, so as to throttle the main induction of the field-magnets, but it is much more often caused by the cross induction. If the armature is drum-wound, throttling the cross induction on one side will do some good in lessening the cross induction; but it is difficult to throttle the cross induction without also throttling the field induction proper, and wasting field-exciting power.

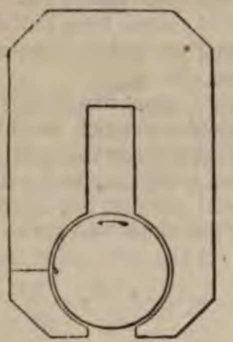

FIG. 2.

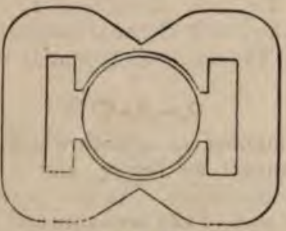

FIG. 3.

Fig. 2 may be taken as a diagram of a 30cm. or 12in. armature machine of about the usual type, with the magnets rather close.

If there were no cross induction the pole-pieces would not be strongly magnetised anywhere; but when the cross induction is superimposed, the neck reaches a high magnetisation, the induction in this case amounting to about B = 15,800 there, and to about B = 17,200 a little higher up. If it were not that the cross induction is lessened by the saturation of the iron, the neck would rise to B = 17,500, and in the region 5cm. or so above the centre line to B = 18,600. The difference of magnetic potential between a point a little below the middle and the top of the pole-piece comes to about 1,880 ergs. The effect of this is that more than 1,000 extra ampere-turns are required on the field magnets. In a Gramme machine the effect is very easily observed by the use of a pilot brush. A resistance of, say, 100 ohms is connected between the terminals of the machine. The pilot brush is connected to one terminal of a detector, and the other terminal is connected successively to points in the resistance, corresponding say, to 95, 90, 85 ohms and so on. The positions of the brush for the zero readings are noted. This avoids errors due to slight variations of speed, which give trouble in the first instance, and errors due to bad contacts. With a drum this method does not give the distribution of the field, as each convolution is on both sides of the armature; but if one pole-piece is highly magnetised by the cross induction, the half of the armature under the upper left and lower right-hand halves of the pole-pieces (in Fig. 2) gives a lower E.M.F. than the other. This effect is sometimes very marked in machines with cast-iron pole-pieces.

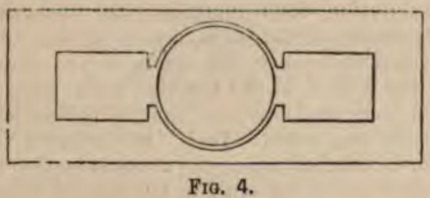

FIG. 4.

A double-magnet two-pole machine can be made up to a larger size than a single by shaping the pole-pieces so as to throttle the cross induction. Two common types of machines are shown in Figs. 3 and 4 with the pole pieces so cut. If it be assumed for the moment that the armature-section current can be reversed with no appreciable field, the largest pole angle that can be used is when the gap induction due to the field excitation is equal and opposite to the cross induction under the leading corner; that is, when

$$\theta = 2\sqrt{\frac{b\ g\ \mathrm{B}_a \times 10}{n\ \mathrm{C}\ (r + \frac{1}{4} g)}} \quad . \quad . \quad . \quad . \quad (7)$$

As the armature sections need a sensible field to reverse them, the pole angle must be less than this.

REVERSAL OF THE SECTIONS UNDER THE BRUSHES.

As a convolution passes under a brush its current falls from the normal to zero, and then rises to the normal in the other direction, and the brush leaves the commutator strip just at that instant, else there would be sparking. To find what field the convolution must be passing through to produce this result, the variation of the number of lines of induction through the convolution must be found, and the time of short-circuiting known. Any lines of induction through the convolution must pass, 1st, round by the field-magnets, thus taking the same course as the field-magnet induction; 2nd, through the armature and air gap in the same way as the field induction, and then from pole to pole across the external air like the field leakage; 3rd, through the iron of the armature in the immediate vicinity of the conductor, and round the conductor by the air. Fig. 5. In a Gramme armature there are two more paths—4, like 3, only inside the armature ring, and 5, round the ring. The last is neutralised by the reversal of the opposite section, and if an uneven number of sections were used the closed armature circuit would damp it. As to the first, any variation of the induction of the field-magnets would be damped by the closed copper field-magnet coils, not to speak of the closed armature-coils forming the belt of back ampere-turns. In addition to this, if the current died away, and increased up to its normal in the opposite direction uniformly, the current-turns linked with the circuits 1 and 2 would remain constant, for on one side there is a constant increase of back current-turns, and on the other the reversed or forward turns are again crossing the lines 1 and 2. There could thus only be variation of induction round circuits 1 and 2 if the current in the section did not change uniformly. Any change in the induction round such a circuit as 2 would be damped by the Foucault currents produced in the pole-pieces, as the current is small and the frequency enormous.

The third course, 3, may be treated as if the convolution were stretched out straight in air. The self-induction could then be calculated. As half the circuit round the wire is through iron, the self-induction may be doubled. The conductor may be taken as a linear conductor, and the self-induction of the active part taken within reasonable limits. To give some idea of the magnitudes dealt with, we may take, as an example, a drum armature of 15cm. radius and 38cm. length, with 120 external conductors, giving 100 volts and 400 amperes at 800 revolutions per minute. The self-induction of the active part may then be taken from 0·5 to, say, 5cm. radius. Then

$$\mathrm{L} = 38\int_{0.5}^{5} \frac{4\,d\,r}{r} \times 10^{-9} = 350 \times 10^{-9},$$

In a drum machine the neighbouring conductors belong to different convolutions, and in this case both are being commutated at the same time: the mutual induction of the convolutions must therefore be taken into account. To calculate the coefficient of mutual induction would involve the calculation of the mean geometrical distance. It will be near enough for the present purpose if the mutual induction is taken at

$$M = 38 \int_1^5 \frac{4\,d\,r}{r} \times 10^{-9} = 244 \times 10^{-9}$$

The active part of the convolution may therefore be taken as having a self-induction of 594×10^{-9}. It is more difficult to get an idea of the self-induction of the end plates. The end plates are flat copper, probably 3cm. or so wide; they are not close to the iron of the armature, but are among other plates, which lessen the effect. Probably $L_2 = 24 \times 10^{-9}$ for each end will be nearly correct. The coefficient of self-induction of a convolution is thus 1,236. The resistance of the convolution is ·000456 ohm. If the brush covers one section and a half, the time of short-circuiting is ·001875. From these data the E.M.F. necessary to bring the current to 200 amperes can be determined—

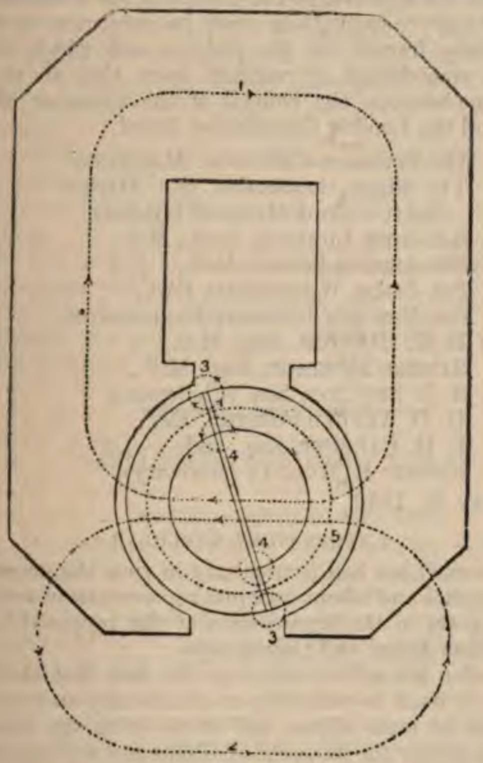

Fig. 5.

$$E = \frac{C\,R\,\epsilon^{-\frac{RT}{L}}}{1-\epsilon^{-\frac{RT}{L}}} + \frac{C\,R}{1-\epsilon^{-\frac{RT}{L}}} = \cdot 274 \text{ volt.}$$

As the velocity of the conductor is 527cm. per second, and its active part is 76·2cm., the field needed to reverse is $B_s = 685$.

It must be borne in mind that this calculation is at best only a rough approximation. In the first place, the field is not really uniform. In the second, the convolution has not really a constant coefficient of self-induction, as that depends on the position of the active part of the conductor in the field, and on the magnetisation of the iron in the armature in its immediate neighbourhood.

If the machine were made with two convolutions per section, and if the brushes still covered one section, it is obvious from the formula that the field necessary to reverse would be twice what it was before, if the self-induction is four times. As a matter of fact, the self-induction would not be nearly four times, for the conductors are too far apart. It would be somewhere between twice and four times.

If there were no self-induction the field necessary to reverse would be just enough to preserve a current of 200 amperes against the resistance of the convolution. If the brush surface were the same the convolution would be short-circuited for, say, 1-40th of a revolution. The loss of power would then be 28 watts. The self-induction prevents the current reversing instantaneously, and makes it change gradually. This reduces the power to about one-third, so 18 watts is about the loss of power due to the short-circuiting of the convolution. The self-induction of the section is thus instrumental in preventing waste of power.

The field necessary for the reversal of the current in a section being known, the position of the brushes can be determined.

If the armature had no current the field would fall off very quickly round the armature after emerging from under the pole-pieces. At no load for instance, the disposition of the lines of induction is, roughly, as shown in Fig. 6. In this case the lines that enter the armature are all cramped together at the pole corners. The lines leaving the shanks of the magnets pass right across and do not enter the armature at all.

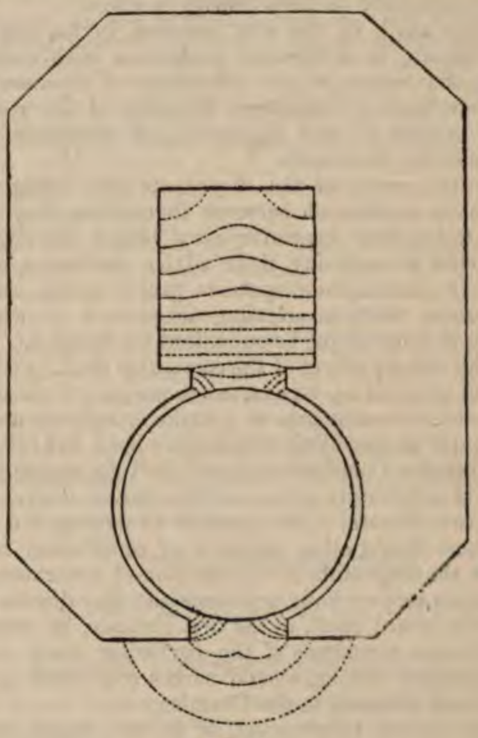

Fig. 6.

To be continued.)

ADJUSTMENT OF LABOUR DISPUTES.

We have received the enclosed copy of the final report of the Conciliation Committee of the Chamber of Commerce, as adopted at the special council meeting, held on the 6th inst.

Further Report of the Labour Conciliation Committee to the Council of the London Chamber of Commerce.

Your committee has endeavoured to devise some practical methods for carrying out the scheme contained in the interim report provisionally adopted by the council on the 12th of December.

The committee offers the following suggestions:

I. That a permanent body be constituted, to be called "The London Conciliation Board," which shall be affiliated to the London Chamber of Commerce, and that its composition shall be as follows—viz.:

(*a*) Twelve members representing capital or employers to be elected by the council of the Chamber.

(*b*) Twelve members representing labour, to be elected by the employed.

(*c*) To these shall be added representatives from the separate Trade Conciliation Committees as hereinafter referred to.

(*d*) The body thus constituted shall add to their number six other members, who from their position, authority, or experience may be useful in promoting the objects of the London Conciliation Board, three to be appointed by the labour representatives on the Board, and three by the representatives of capital.

(*e*) Four members—viz., the Lord Mayor of London, or some member of the Corporation to be nominated by him, the chairman of the London County Council, or some member of the Council to be nominated by him, a representative of the London Trades Council, and a representative of a London labour organisation to be selected by the labour representatives on the Board.

The elections shall take place every three years, and the first election shall take place on the ——

II. The duties of the London Conciliation Board shall be as follows :

(*a*) To promote amicable methods of settling labour disputes and the prevention of strikes and lock-outs generally, and also especially in the following methods :

1. They shall, in the first instance, invite both parties to the dispute to a friendly conference with each other, offering the rooms of the Chamber of Commerce as a convenient place of meeting. Members of the committee can be present at this conference, or otherwise, at the pleasure of the disputants.

2. In the event of the disputants not being able to arrive at a settlement between themselves, they shall be invited to lay their respective cases before the committee, with a view to receiving their advice, mediation, or assistance. Or, should the disputants prefer it, the committee would assist them in selecting arbitrators to whom the question at issue might be submitted for decision.

3. The utmost efforts of the committee shall, in the meantime and in all cases, be exerted to prevent, if possible, the occurrence or continuance of a strike or lock-out until after all attempts at conciliation shall have been exhausted.

The London Conciliation Board shall not constitute itself body of arbitrators except at the express desire of both parties to a dispute, to be signified in writing, but shall in preference, should other methods of conciliation fail, offer to assist the disputants in the selection of arbitrators chosen either from its own body or otherwise. Any dispute coming before the Board shall, in the first instance, be referred to a conciliation committee of the particular trade to which the disputants belong, should such a committee have been formed and affiliated to the Chamber.

(*b*) To collect information as to the wages paid and other conditions of labour prevailing in other places where trades or industries similar to those of London are carried on, and especially as regards localities either in the United Kingdom or abroad where there is competition with the trade of London. Such information shall be especially placed at the disposal of any disputants who may seek the assistance of the London Conciliation Board.

III. The separate Trade Conciliation Committees shall be composed of equal numbers of employers and of employed.

Each trade shall elect its own representatives, employers and employed voting separately for the election of their respective representatives. The number of members and the general rules of procedure shall be determined by each particular trade, subject to the approval of the London Conciliation Board.

The Trade Conciliation Committees shall be affiliated to the London Chamber of Commerce, and shall be represented upon the London Conciliation Board. Any Trade Conciliation Committee constituted as above representing a body or trade in the metropolitan districts of more than 1,000 individuals shall send two representatives to sit on the London Conciliation Board, one being an employer and the other an operative workman, each to be separately elected by employers and employed respectively. In the case of Trade Conciliation Committees representing bodies or trades in the metropolitan districts smaller in number than 1,000 individuals, two or more such committees may unite together to elect joint representatives to the London Conciliation Board.

It shall be the duty of the Trade Conciliation Committees *to discuss* matters of contention in their respective trades; *to endeavour amicably to arrange* the same, and in general to promote the interests of their trade by discussion and mutual agreement. In the event of their not being able to arrange any particular dispute they will refer the same to the London Conciliation Board, and in the meantime use their most strenuous endeavours to prevent any strike or lock-out until after the London Conciliation Board shall have exhausted all reasonable means of settlement.

They may from time to time consider and report to the London Conciliation Board upon any matter affecting the interests of their particular trade upon which it may be thought desirable to employ the action or influence of the London Chamber of Commerce as a body.

IV. The London Chamber of Commerce places its rooms at the disposition of the London Conciliation Board and of the Trade Conciliation Committees for holding their meetings. Any alterations in the rules and regulations of these bodies which may be from time to time proposed shall be submitted for approval to the council of the Chamber.

V. The above regulations shall be subject to by-laws to be specially framed for the purpose, and which shall be open to amendment as required from time to time, on agreement between the council of the Chamber of Commerce and the London Conciliation Board.

His Eminence CARDINAL MANNING,
The Right Honourable SIR HENRY ISAACS (Lord Mayor of London),
SIR JOHN LUBBOCK, Bart., M.P.,
SIR ALBERT ROLLIT, M.P.,
SIR JAMES WHITEHEAD, Bart.,
SIR VINCENT KENNETT-BARRINGTON,
R. K. CAUSTON, Esq., M.P.,
SAMUEL MONTAGU, Esq., M.P.,
S. B. BOULTON, Esq. (Chairman),
H. O. ARNOLD-FORSTER, Esq.,
E. H. CARBUTT, Esq., and
KENRIC B. MURRAY (secretary),
Members of the Committee.

January 31, 1890.

EXPLANATORY CIRCULAR.

The council has had particularly in view the necessity of giving capital and labour an equal representation and equal voting power in the organisation of the proposed London Conciliation Board and Committees.

Attention is specially called to the fact that this Board will not in itself be primarily or of necessity an arbitrating body, but its main object will be to bring the interested parties together for purposes of discussion and explanation at the earliest stage of any difficulty, with the view of preventing that difficulty reaching the acute stage of strike or lock-out, arbitration being only suggested in the last resort. It is hoped that the existence of a permanent Board composed of experiened and influential representatives of both capital and labour, to whom any difficulty arising in the labour market can be referred for discussion and consideration at an early period, may, by intervention in a friendly and disinterested manner, enable points of difference to be settled by mutual consent without any stoppage of trade. Should the difficulty, however, prove to be acute or not one of a nature for settlement on general grounds, the Board will have powers to assist the disputants in nominating special arbitrators. One very important function of the Board will be to assist in promoting the formation of separate Trade Conciliation Committees for the various industries carried on in the metropolis, to whom all disputes affecting those particular industries will in the first instance be referred.

COST OF ELECTRIC LIGHT IN PARIS.

The cost of the production of the electric light at the various installations undertaken by the Municipal Council of Paris are given in a recent report by M. Paul Brousse, municipal councillor.

HOTEL DE VILLE.—The installation at the Hotel de Ville comprises 500 16-c.p. lamps and 4,000 10-c.p. lamps, the latter run on fête days. The plant comprises two Edison dynamos, 110 volts and 200 amperes, five Gramme dynamos, 110 volts, three of 250 amperes and two of 500 amperes. The cost of maintenance is ·84d. per 16-c.p.

lamp-hour. The lighting is only maintained during certain months of the year, and three or four times only with the whole of the lamps.

Place du Carrousel.—Since July, 1889, the Place du Carrousel has been lighted with Pieper lamps driven from the Edison station in the Palais Royal. The lamp-hour (probably 300 candles) works out at 6·3d.

Parc Monceau.—The Parc Monceau is lighted with 20 Jablochkoff candles, fed by three Gramme alternate-current dynamos. The price of the arc-hour is 4·8d. (about 200 c.p.).

Buttes Chaumont.—In the Parc de Buttes Chaumont 46 Brush arc lights (about 400 c.p) are run in series, and 16 lamps of 16 c.p. are also installed in a restaurant. The cost is ·2d. per 16 c.p. or 4d. per arc-hour.

Station des Halles.—Although no actual data are yet given, M. Meyer calculates that the 100 watt-hours will cost ·5d. or ·6d., including all cost except rent.

Grands Boulevards.—During the Paris Exhibition the lighting of the grand boulevards was carried out by the Popp Company, the Edison Company, and the Société Rothschild-Marcel Deprez. The expenses have been as follows :

Popp Company, 40 arcs, 700 c.p., of 10 amperes, 10·05d. per arc-hour.

Edison Company, 37 arcs, 700 c.p., of 40 amperes, 8·2d. per arc-hour.

Société pour la Transmission de la Force, 27 arcs, 700 c.p., 10 amperes, 8·2d. per arc-hour.

The total expense incurred for the municipal lighting by electricity in Paris amounts to 782,750f. (about £32,000), of which 100,000f. was appropriated for trials.

PHYSICAL SOCIETY.—Feb. 7.

ANNUAL GENERAL MEETING.

Prof. Reinold, F.R.S., President, in the chair.

The reports of the council and of the treasurer were read and adopted. The former stated that there had been a very satisfactory increase in the number of members during the year. The number now exceeds 360, of whom 80 are Fellows of the Royal Society. During the year the council had proposed to change the time of meeting of the society from Saturday afternoon to Friday evening. The change was adopted by the members by a vote of 129 to 30, and had resulted in a larger attendance at the meetings. During the year the second volume of the translations of important foreign memoirs had been issued to the members, and it was hoped that a third volume would be published early in the present session. The council had to regret the loss by death of three well-known members, James P. Joule, Warren de la Rue, and Father Perry. A valuable collection of books had been given the society by the Royal Astronomical Society. From the treasurer's report it appeared that the balance of the society had been increased by £120 during the year. Prof. Hittorf, of Münster, was, at the recommendation of the council, elected an honorary member of the society.

The result of the new election of officers was declared as follows : President, Prof. W. E. Ayrton, F.R.S. ; vice-presidents, Dr. E. Atkinson, Walter Bailey, M.A., Shelford Bidwell, F.R.S., and Prof. S. P. Thompson, D.Sc. ; secretaries, Prof. J. Perry and T. H. Blakesley, M.A., M.I.C.E. ; treasurer, Prof. A. W. Rücker, F.R.S.; demonstrator, C. V. Boys, F.R.S. ; other members of council, W. H. Coffin, Sir John Conroy, Bart., M.A., Conrad W. Cooke, Major-General Festing, F.R.S., Prof. J. V. Jones, M.A., Prof. O. Lodge, D.Sc., F.R.S., Prof. W. Ramsay, Ph.D., F.R.S., W. N. Shaw, M.A., H. Tomlinson, B.A., F.R.S., and G. M. Whipple, D.Sc.

Votes of thanks were then passed (1) to the Lords of the Committee of the Council on Education for the use of the room in which the society met, (2) to the auditors, Prof. Minchin and Dr. Fison, (3) to the president and officers of the society for their services during the year.

The meeting was then resolved into an ordinary science meeting. Messrs. E. W. Smith and C. E. Holland, B.A., were elected members of the society, and Mr. Sydney Evershed was proposed as a member.

The paper on "**Galvanometers,**" by Prof. W. E. Ayrton, F.R.S., Mr. T. Mather, and Dr. W. E. Sumpner, was then resumed by Prof. Ayrton. A long table of numbers accompanying the paper and representing the result of experiments on many galvanometers was explained. From this it appeared that galvanometers of the D'Arsonval type were exceedingly efficient in proportion to the amount of wire used in the coils. It was for this reason that voltmeters with strong permanent magnets could be made sensitive even with an exceedingly large external resistance in series, so as to diminish the power absorbed by the instrument. The space occupied by the wire was so exceedingly valuable that the extra resistance did not too much diminish the sensibility. The most sensitive galvanometers should therefore be made of the permanent magnet type. If, however, the magnets were to form part of the moving system, as in most galvanometers, the experiments showed that instruments of the Rayleigh, Gray, or Rosenthal type were the best. The coils should be numerous and small, as Mr. Boys had previously shown. As an astatic system of needles sets itself perpendicular to the earth's field, it was recommended that astatic galvanometers should be placed so that the needles pointed east and west. The controlling magnet would then not need to be turned round as it was raised or lowered. It was recommended to calibrate low resistance ballistic galvanometers for quantity by measuring the deflection for a known current. This obviates the necessity for large condensers or high potentials. The method, although not new, is not described in text-books. In conclusion, Prof. Ayrton asked for information with regard to microscope galvanometers. **Mr. C. V. Boys, F.R.S.**, thought that the factor of merit of galvanometers should not be given in scale divisions per micro-ampere under the condition of constant controlling moment. This gave too great an advantage to instruments of the Gray or Rosenthal type Great sensibility could be obtained by diminishing the moment of inertia of the suspended parts, the practical limit being determined by the trouble due to the silk fibre. Spider lines, when used in place of silk fibres, gave better results. It was possible by using a good suspending arrangement to use needles ⅛in. long, and a period of 20 seconds, and to gain a sensibility far greater than those indicated in the paper. Ballistic galvanometers should be made with needles as light as possible. The method proposed of winding the central part of the coil in the opposite sense to the rest would probably not be good, owing to the unevenness of the field produced. The conclusion come to by the authors, that D'Arsonval galvanometers of great sensibility should be made with small coils placed in a very strong field, was one he had himself come to, but had finally abandoned owing to difficulties caused by diamagnetism in the copper and to excessive damping due to Foucault currents. **Mr. Swinburne** thought that the factor of merit of a galvanometer should be determined differently according as it was to be used for the measurement of current, or quantity, or for null methods merely. He saw no great advantage in making practical instruments proportional. The name D'Arsonval should be dropped, as the instrument denoted by it was invented by Varley years ago. He would like to know the relative sensibility of the telephone and the Lippman galvanometer. **Prof. Fitzgerald** stated that Lord Rayleigh had shown that the microscope method of observing angular deflections was as sensitive as the ordinary method of mirror and scale even when only the mirror was used as a pointer, so that if a pointer were attached it would be far more sensitive. The drawback, however, was that it was impossible to distinguish with the microscope between lateral displacements of the needles and the angular motion whose measurement was required. To get over this error it was necessary to read both ends of the pointer, but this was hard to do. **Prof. Ayrton** replied to the different points raised in the discussion.

COMPANIES' MEETINGS.

TAUNTON ELECTRIC LIGHTING COMPANY.

The annual meeting of the Taunton Electric Lighting Company, Limited, was held on Monday evening at The Castle Hotel, Taunton.

The **Chairman**, having read the report, moved that the report be adopted, and that a dividend of 5 per cent., free of income tax, be declared payable on and after Feb. 11, 1890. Referring to the work of the past year, he said that they would doubtless remember that in the report issued 12 months ago there was an intimation, not that they were about to erect a new depot, or purchase a new site, but that they were about to purchase improved machinery, which would have the effect of saving a considerable sum in the cost of fuel, etc. Early in the year, however, the Directors gave their careful consideration to the procuration of a new site for their depot, and secured by public auction a suitable piece of land. No sooner had the purchase been effected than the town was visited by a most disastrous flood, which rendered their recent acquisition about as visible as if it had been at the bottom of the deep blue sea. That being so, the Directors were very much concerned as to the future of the site, and it was suggested that to utilise that land they would have to build arches upon which to erect their machinery. This would have involved an additional outlay of about £500, an expense which they considered large and unnecessary. Under these circumstances they began to look for a more suitable site, and they had bought a piece of land which, he believed, would serve their purpose admirably, its situation being excellent in many respects. They had two entrances, and while being almost in the centre of the town, the machinery had been placed in such a situation that the least possible annoyance by the noise would be caused to the neighbours, indeed they hoped that there would be no annoyance caused whatever by the machinery. They had now nearly completed their depot, and the shaft was a landmark which could be seen a long way round Taunton, serving as a valuable advertising medium. The work of laying down the machinery was in progress, and they hoped in two or three weeks they would be in full working order, having quitted Fore-street for the splendid depot in James's-street. Then would commence a new epoch in the electric lighting of the town ; they would be able to supply a larger number of consumers, and, moreover, hoped to save a considerable sum in fuel. The cost of coal, etc., had hitherto been about £450 a year ; that was a very large sum, but the plant and machinery was of such a nature that they could not possibly carry on the work they had done without a large consumption of coal. In conclusion, he said that the shareholders might be assured that the Directors would do their best to place the Company on a satisfactory basis, so that at the end of the year they would be able to present to them a report as satisfactory, if not better, than the one he now submitted to them for acceptance.

Mr. W. Potter seconded the adoption of the report, and remarked that the Company had had many applications during the past year for lights, which they had been obliged to refuse, simply because the plant had been altogether inadequate. But now that they contemplated, within the next month or so, removing to the new depot they would be able to carry out the orders. They had every prospect of considerably increasing their business during the next year.

The report and balance-sheet were adopted.

At the request of the chairman, **Mr. Down** (of Messrs. Laing, Wharton, and Down) stated that his firm last week got the contract for lighting one-half of the streets of London and the monopoly of the private lighting. He expected they would get the contract the next day for lighting another town about as large as Taunton. He was glad to see that the Taunton company had got such a splendid situation for their depot. They had ample room for extension there, which would certainly meet the requirements for many years to come. He and Mr. Massingham had estimated that they would be able to provide for something like 15,000 lamps.

Mr. Massingham, referring to the affairs of the Company, said that during the past year they had been placed at considerable disadvantage because of the large expenditure incurred, while the income could not be increased at anything like the same proportion, because they could not meet the demands of the would-be consumers. But directly they entered the new depot they would be able to supply any number of consumers. Nevertheless, he was pleased to say that so far they had been making gradual and steady progress. The first year (1887) the dividends and interest on debentures amounted to £341. 19s. 6d., the second year (1888) they paid £422. 0s. 5d., and last year they paid £502. 9s. 5d. There had therefore been a very satisfactory growth in their revenue. There had been an increase in their share capital during the year of between £6,000 and £7,000, a very good testimony of the success of the Company, showing that Taunton people, who were at one time, perhaps justifiably, shy of anything so uncertain as the electric light, were now having faith in it. During the past year they had had a number of deputations visiting Taunton, and they were likely to have many others in the future. Amongst others, there was a deputation coming from Dublin. It was very gratifying to them all that a small town like Taunton should have important deputations from Corporations like Dublin, and it was still more gratifying to see that whenever they have visited Taunton the result has been that they have done what Taunton had done. One of the technical papers some time ago stated that Taunton had been of greater assistance in developing electric lighting than any other town in the kingdom, and when any corporation had decided upon electric light they had in the first place visited Taunton. Taunton had not suffered from any disaster such as had been experienced at Leamington. There they had spent £30,000 on plant, etc., whereas in Taunton they had not spent half that amount. In Leamington the system had failed, and he was glad to hear that the Corporation had decided to practically throw over what they had done and commence again.

Mr. A. A. Chapman said that the Company had congratulated themselves on the perfection of their system, but he thought that some credit was due to the working staff for the way they had carried on the work. He therefore moved a vote of thanks to the staff for successfully carrying on the work.

This was seconded by **Mr. Massingham**, who said the staff had done exceedingly well and looked forward to doing still better in the future.

Mr. Thomas, electrician-in-charge, acknowledged the compliment, and the meeting terminated with a vote of thanks to the Chairman for presiding.

COMPANIES' REPORTS.

CHELSEA ELECTRICITY SUPPLY COMPANY, LIMITED.

Directors: The Right Hon. Lord Thurlow, F.R.S., J. Irving Courtenay, Esq., Nugent Daniell, Esq., Sir George Prescott, Bart., J.P., Major-General Webber, C.B. (retired R.E.). Secretary: S. J. Cluer. Solicitors: Sydney Morse, Esq., Messrs. Renshaw. Auditors: Messrs. Cooper Bros. and Co.

Report of the Directors for the year ending December 31, 1889, to be presented at the annual general meeting of the shareholders to be held at their central station, Draycott-place, Sloane-square, S.W., on Wednesday, February 19, 1890, at 12 o'clock.

Up to May, 1888, when the last report was issued, the Company had only been able to take preliminary steps for its development. In July of that year the Electric Lighting Bill, introduced to Parliament by Lord Thurlow, having passed both Houses, the Board of Directors was reformed, and a prospectus was published. The capital requisite to proceed with the construction of a generating station, and to put down the necessary plant for the distribution of electricity within the first area of supply, as included in their Act, was then obtained. The necessary contracts for building and plant having been made, work was commenced in the latter end of 1888, and in an unprecedentedly short time the central station was completed, under the supervision of the Company's architect, Mr. F. G. Knight, of 6, Great College-street, Westminster. Early in April, 1889, the station was so far ready that experimental plant was put to work, but owing to a delay in supplying the engines, arising out of the destruction by fire of the works of Messrs. Willans and Robinson, of Thames Ditton, and several other causes, the period of experiment and preparation continued until the end of September, after which the work of regular and extended supply came into operation. At the outset the Company had to encounter competition within its area of supply of two other ompanies, neither of which were operating under parliamentary powers. These companies proposed to invade the district with overhead lines, and thus take advantage of the uncertainty of the law on the subject to obtain some custom at a comparatively small outlay. By strenuous opposition, by actively pushing on the completion of its works, and by subsequently entering into a friendly arrangement (approved by the Board of Trade and the Chelsea Vestry) with one of those companies, the Company has succeeded in neutralising any effect which this desultory competition might have otherwise had on its business. At the Board of Trade enquiry held at Westminster Town Hall in March and April, 1889, the Company, represented by Mr. Fletcher Moulton, Q.C., and Mr. R. S. Wright, successfully defended its position, and succeeded in showing that the system it had adopted, now commonly known as the Chelsea system, was at least equal to any other system under enquiry. One result of this enquiry was, that the Company, with the consent of the Kensington Vestry, obtained a provisional order for a part of that parish, known as the South Kensington Electric Lighting Order, 1889. The contracts for the plant to extend the system into Kensington were again undertaken by the three contracting companies—namely, the Brush Electrical Engineering Company, Limited; the Callender's Bitumen Telegraph and Waterproof Company, Limited; the Electric Construction Corporation, Limited. These companies agreed to receive payment in fully paid-up shares of the Chelsea Company. Since early in December current has been supplied in South Kensington. The Company has obtained the sanction of the Board of Trade and of the Chelsea Vestry to extensions of their area of supply on the south, and on the north of their first area up to Knightsbridge, including the Lowndes-square district. They have nearly completed the erection of a fourth storage station at the northern end of Pavilion-road, and have made all the arrangements for laying down the necessary mains throughout those areas. In the erection of the Company's central station, the Directors were obliged to provide a building of sufficient capacity for all probable future demands and extension of area of supply. The building includes space for a generating plant to supply a total of 30,000 (8 to 10 c.p.) lamps in use at one time, representing a total of 60,000 installed. Besides, it contains one storage station, the necessary offices, and residential accommodation for some of the staff. The outlying storage stations of the Company in use, or about to be put to use, are now in Clabon-mews, Pavilion-road, and Egerton-gardens, and negotiations are in hand for a fourth. The Company has received many testimonials from its customers, expressing the most marked approval of the system of supply. The causes for this satisfaction continue, and they may be chiefly traced to the perfect steadiness of the light, and the consequent economy of wear and tear of glow lamps, and total absence of any interruptions to the light which the system secures. The steady and gratifying growth of the Company's business is exemplified by the following statement. The table shows the relation between running and revenue expenses in the months of October, November, and December, 1889, being the first regular quarter, and bears remarkable evidence of the proportionate increase of income, as compared with expenses as custom extends.

Statement showing actual cost (exclusive of general charges) of running machinery and storage stations, and the revenue received for current supplied during the three months ending December 31, 1889.

	£	s.	d.		£	s.	d.
Oct.—Coal, water, oil, waste & wages, removal of ashes and fitters' time	82	0	10	Oct.—Current invoiced.	146	1	6
Nov. ,, ,,	114	14	0	Nov. ,, ,,	262	8	2
Dec. ,, ,,	141	9	6	Dec. ,, ,,	405	12	0

In order to complete the works in hand, and to be ready to meet the cost of the necessary extensions, the Directors seek the approval of the shareholders to the creation of debentures to the amount of £50,000. The retiring Directors are Major-General Webber and Mr. Daniell, who, being eligible, offer themselves for re-election. The auditors, Messrs. Cooper Bros. and Co., also offer themselves for re-election.

BALANCE SHEET, DECEMBER 31, 1889.

Including expenditure since the formation of the Company, Nov. 18, 1884.

Dr.	£	s.	d.	£	s.	d.
Capital account—						
Authorised	100,500	0	0			
3,164 shares of £5 each fully paid	15,820	0	0			
2,185 ,, ,, £4 ,,	8,740	0	0			
1,262 ,, ,, £2 ,,	2,524	0	0			
6,611	27,084	0	0			
Less calls in arrear	22	10	0			
	27,061	10	0			
250 founders' shares of £1 each	250	0	0			
				27,311	10	0
Loan				6,500	0	0
Creditors—						
Amount due to contracting companies under agreement to take payment in fully paid shares or cash at this Company's option	9,095	0	0			
Amount due to contracting companies for extra plant and to sundry other creditors	3,529	15	10			
Directors' fees unpaid	600	0	0			
				13,224	15	10
Balance				179	9	9
				£47,215	15	7

Cr.	£ s. d.	£ s. d.
Outlay on capital account—		
Preliminary and preparatory and experimental work, as per last account	579 11 1	
Ditto from 4th May, 1888, to date—viz. :		
Advertising and canvassing	639 7 1	
Legal and parliamentary fees, interest, and commission	900 16 5	
Rent, rates, and taxes, insurance, &c.	402 4 2	
Preliminary expenses, Kensington and Belgravia	431 3 1	
Office expenses, management, and salaries, stationery, postage and travelling	1,282 8 9	
Way-leaves	62 10 0	
Labour and material on preparatory work of supply...........................	362 11 10	
Board of Trade enquiry, legal and other expenses	765 17 7	
Founders' shares	250 0 0	
	5,676 10 0	
Deduct receipts for meter rent and current supplied during construction	278 1 7	
		5,398 8 5
Leasehold buildings—		
Central station, Draycott-place, and sub-storage station at Draycott-place, Clabon-mews, and Egerton-mews		9,045 14 5
Plant—		
Including all generating machinery and accessories, with storage plant, and system of distribution by mains up to the houses of customers		27,733 13 6
Stock—		
Stores on hand..............................	559 11 2	
Labour and material on works in progress.........................	40 18 11	
		600 10 1
Office furniture and fixtures		128 2 4
Sundry debtors		1,175 9 11
Suspense account—		
Accounts under revision and chargeable to 1890	184 4 2	
Directors' fees	600 0 0	
		784 4 2
Cash—In hand........	27 8 1	
At bankers	1,122 4 8	
On deposit with Board of Trade	1,200 0 0	
		2,349 12 9
		£47,215 15 7

PROFIT AND LOSS ACCOUNT FOR THE QUARTER ENDING 31ST DECEMBER, 1889.

Dr.	£ s. d.	£ s. d.
To coal, oil, water, cotton waste, &c.	249 11 3	
Wages	118 16 6	
		368 7 9
General charges—		
Canvassing	9 6 7	
Office and general expenses, including stationery, carriage, travelling, and postages	101 15 5	
Insurance	10 10 7	
Interest...	79 6 7	
Rates and taxes	22 17 6	
Rent	45 17 6	
Salaries...	142 11 0	
Way-leaves	65 5 0	
		477 10 2
Balance		179 9 9
		£1,025 7 8

Cr.	£ s. d.
By revenue for current, etc., balances on accounts for connecting up houses and meter rent, etc...	1,025 7 8
	£1,025 7 8

INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS COMPANY, LIMITED.

Directors.—S. Wm. Silver, Esq. (chairman); Neil Bannatyne, Esq.; Abraham Scott, Esq.; Matthew Gray, Esq. (managing director); Robert Henderson, Esq.; the Hon. Henry Marsham; A. Weston Jarvis, Esq., M.P.

Report of the Directors for the year ending December 31, 1889, to be presented at the twenty-sixth ordinary general meeting of the shareholders, to be held at the Cannon-street Hotel, London, on Friday, February 14th, 1890, at half-past 1 o'clock in the afternoon.

The annexed accounts show the net profit for the past year to be £57,748. 9s. 1d. Adding £25,087. 17s. 7d. brought forward, and deducting £20,800 interim dividend paid in July, there remains a disposable balance of £62,036. 6s. 8d. The Directors recommend the distribution of a dividend of 10s. per share, free of income tax, amounting to £20,800, making, with the interim dividend, a total payment for the year of 10 per cent., and leaving £41,236. 6s. 8d. to be carried forward. The Company's general business has been well maintained; and the laying of the 800 miles of cable mentioned in the last report was successfully completed. At the instigation of unprincipled agitators, almost all the Company's workpeople went out on strike in the middle of September, and remained out from 10 to 12 weeks. The result to them was the loss of about £20,000, which they would have received in wages. The loss to the Company was but small, as other means were available for the execution of orders. For the greater convenience of the Company's business, freehold premises have been purchased in Liverpool adjoining those hitherto occupied, the lease of which runs out in the present year; and, in consideration of an extended lease at a reduced rent, the premises in Cannon-street have been rearranged and greatly improved, and fitted with electric light. The Company's works and machinery are in efficient working order. Mr. Silver and the Hon. Henry Marsham, the directors retiring by rotation, offer themselves for re-election. The auditor, Mr. Weise, retires, and is re-eligible.

BALANCE-SHEET, DEC. 31, 1889.

Capital and Liabilities.

Dr.	£ s. d.
Amount of authorised share capital	812,000 0 0
Share capital—Amount subscribed and paid on authorised issue of 41,600 shares of £10 each	416,000 0 0
Mortgage debentures	200,000 0 0
Reserve fund	275,000 0 0
Steamers' maintenance fund.......	5,000 0 0
Debts owing by the Company	35,887 5 8
Unclaimed dividends	37 0 0
Proposed dividend, 5 per cent.........	20,800 0 0
Amount carried forward to 1890, as below.........	41,236 6 8
	£993,960 12 4

Assets and Expenditure.

Cr.	£ s. d
Freehold land, buildings, and machinery at Silvertown and at Persan-Beaumont, and steamships "Silvertown," "Dacia," "International," and "Buccaneer"	463,640 4 7
Freehold premises at Liverpool, and expenditure on Cannon-street premises	19,000 0 0
Debts owing to the Company	56,917 0 10
Cash with bankers, in hand, and on deposit.....	55,393 18 7
Bills receivable	3,653 12 0
Stock-in-trade (including 120 miles of cable)...	210,003 19 9
Debentures and shares in other companies...	43,290 10 0
Cash, stock, &c., at Persan and other agencies..... ..	142,061 6 7
	£993,960 12 4

PROFIT AND LOSS ACCOUNT FOR THE YEAR ENDING 31ST DECEMBER, 1889.

Dr.		£ s. d
Salaries, interest, rent, rates and taxes, repairs, and general expenses		53,696 3 7
Bad debts		1,774 14 1
Income tax		1,477 5 8
Depreciation written off buildings and machinery and steamship "International".....		23,967 16 6
Directors' remuneration (minimum)		2,000 0 0
Balance—profit for the year, carried down		59,542 14 1
		£142,458 13 11
		£ s. d
Interim dividend of 5 per cent. paid in July..	£20,800 0 0	
Proposed dividend of 5 per cent...	20,800 0 0	
		41,600 0 0
Balance to be carried forward to 1890		41,235 6 8
		£82,836 6 8

Cr.		£ s. d.
Gross profit, after charging commission, but including interest and profit on debentures and shares in other companies		£141,458 13 11
Amount recovered for patent infringement (balance)		1,000 0 0
		£142,458 13 11
		£ s. d.
Balance brought down	£59,542 14 1	
Less additional remuneration due to Directors after payment of 10 per cent. to shareholders.........	1,794 5 0	
		57,748 9 1
Amount brought forward from 1888		25,087 17 7
		£82,836 6 8

REPORT OF THE DUBLIN SPECIAL COMMITTEE.

The following is the report of the Special Committee *re* electric lighting, recommending the appointment of an electrical superintendent.

To the Right Hon. the Lord Mayor, Aldermen, and Burgesses of Dublin.—Your committee beg to request the sanction of the Council to the appointment of an electrical superintendent, at a salary of £200 a year, with an increment depending on his efficiency and the success of the works. Your committee propose that, in accordance with the report of the whole house of January 26, 1887 (No. 16) the office to be appointed shall be under the control of the borough surveyor, who shall have the same responsibility for the discharge of his duties by this officer as he has in the case of the assistant engineers and other officers in charge of works. Your committee are satisfied that this arrangement will conduce to the rapid and satisfactory completion of the necessary street works, and tend to maintain the consolidation of the administration.

Having regard to the large expenditure about to be entered on, it is essential that the Corporation should have competent technical knowledge available in the selection of appliances, the determination between different modes of carrying out works, and the arrangement of contracts, and, under these circumstances, your committee beg to recommend that such appointment be declared necessary; and as the Board of Trade has decided that the license to supply electricity for private purposes shall run concurrently with that for public purposes, your committee beg to recommend that the appointment be made by Council at the earliest practicable date; and, meanwhile, that the requisite steps be taken by your committee to invite candidates, examine their qualifications, and submit recommendations thereon to Council.

All which your committee submit as their report, this 22nd day of January, 1890.

NEW COMPANIES REGISTERED.

Fareham Electric Light Company, Limited.—A Company under this title has been founded for the purpose of supplying electricity both for public and private lighting, and also for motive power, in the town of Fareham and its vicinity. The capital is £5,000 in shares of £1 each, of which 1,600 are now offered for subscription.

Mutual Telephone Company, Limited.—Registered by Rowcliffes, Rawle, and Co., 1, Bedford-row, W.C., with a capital of £100,000 in £10 shares. Object: to carry on any business relating to telephones or telephone apparatus, or any business which may be advantageously carried on therewith. The first subscribers are:

	Shares.
W. D. Provand, 9, Bridge-street, Westminster	1
G. Hahle, 100, Portland-street, Manchester	1
H. T. Gaddum, 57, Brown-street, Manchester	1
E. Guthrie, 71, King-street, Manchester	1
W. Thompson, 79A, Princess-street, Manchester	1
W. Mallison, 105, Princess-street, Manchester	1
E. A. Hague, 6, Dickinson-street, Manchester	1
W. Wadsworth, 4, Albert-square, Manchester	1
A. Forrest, Hoet Town, Manchester	1

There shall not be less than five nor more than 15 Directors; the first to be appointed by the subscribers to the memorandum of association. Qualification, 10 shares. Remuneration to be determined in general meeting.

CITY NOTES.

Change of Address.—The offices of the Commercial Telegram Bureaux have been removed to 11, Tokenhouse-yard. The Commercial Press Telegram Bureaux has been removed to 5, Copthall-chambers, Telegraph-street, E.C.

Western and Brazilian Telegraph Company, Limited.—The receipts for the week ended February 7, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,804.

Telegraph Construction and Maintenance Company, Limited. Subject to the audit of the accounts, the Directors of this Company propose paying a dividend of 15 per cent. (£1. 16s. per share), in addition to the 5 per cent. already paid, making 20 per cent. for the year 1889.

India Rubber, Gutta Percha, and Telegraph Works Company, Limited.—This Company, in the report for the year ending December 31, show a net profit of £57,748. Adding £25,087 brought forward, and deducting £20,800 interim dividends, there remains a disposable balance of £62,036, out of which they recommend a dividend of 10s. per share (tax free), making a total for the year of 10 per cent., and leaving £41,236 to be carried forward.

Brush Electrical Engineering Company.—The Directors have decided to pay an interim dividend upon the preference shares of the above Company, and warrants for a dividend on these shares at the rate of 6 per cent. per annum from August 10, 1889 (the date of the registration of the Company), to February 10, 1890, will be issued on the 1st proximo. As the books of the Company will not be made up until the close of the year, the Directors defer the question of a dividend on the ordinary shares until the complete accounts are before them.

Companies of the Month.—The following electrical companies have been registered during the past month:

Electrical Engineering Corporation, Limited, £5 shares	150,000
Fowler, Lancaster, and Company, Limited, electricians, £10 shares	22,000
Morgan's Automatic Electric Signal System Syndicate, Limited, £100 shares	5,000
Monte Video Tramways Company, Limited, £1 shares	100,000
Mutual Telephone Company, Limited, £10 shares	100,000
Norwich Electricity Company, Limited, £10 shares	50,000
Universal Electric Light and Power Trust Corporation, *Limited, £10 shares*	5,000

Brazilian Submarine Telegraph Company.—The traffic receipts for the week ended February 7 amounted to £5,014.

Electrical Engineering Corporation, Limited.—The capital of this Company is £150,000 in 29,600 ordinary and 400 founders' shares of £5 each, with £20,000 in 200 6 per cent. mortgage debentures of £100 each, and the issue is announced of 15,000 ordinary shares, the founders' shares, and the debentures. The Corporation has been formed to take over as going concerns (*a*) the business of Messrs. J. G. Statter and Co., Limited, electrical and general engineers and ironfounders, with their freehold and leasehold properties, their works, dock, and wharf, situated at West Drayton, and their plant, stock, patents, and goodwill; and (*b*) the business of the United Electrical Engineering Company, Limited, electrical engineers and contractors, including the rights and patents of that company, together with their leasehold premises, works in Lambeth, and their plant, stock, and goodwill. The purchase price is fixed at £26,000 for each concern.

PROVISIONAL PATENTS, 1890.

FEBRUARY 3.

1784. **Improvements in and connected with the production of ozone by means of electricity.** Thomas Alexander Garrett, 29, Wynnstay-gardens, Kensington, London.

1822. **Improvements in electrically-actuated whistles, trumpets, and horns, and in speaking tubes for domestic and business use, for hotels, for train intercommunication, and other purposes.** Joseph Lee 77, Chancery-lane, London.

FEBRUARY 4.

1867. **Improvements in electrical conduits and conductors.** John Alexander McMullen, 9, Warwick-court, High Holborn.

1878. **Improvements in electric insulating compounds.** James B. Williams, 18, Buckingham-street, Strand, London. (Complete specification.)

FEBRUARY 5.

9139. **An automatic electric temperature alarm.** Marie Henri Leonide Bougault, 18, Buckingham-street, Strand London.

FEBRUARY 8.

2080. **Improvements in devices for unloading, recharging, and reloading electric car storage batteries.** Jacob Chester Chamberlain, 23, Southampton-buildings, Middlesex. (Date applied for under Patents Act 1883, Section 103, 10th July, 1889, being date of application in United States.)

2091. **Improvements in secondary batteries and plates or elements therefor.** William Phillips Thompson, 6, Lord-street, Liverpool. (The Gibson Electric Company of Europe, France.)

2108. **Improvements in or connected with switches for controlling electro-motors.** Charles Thomas Whitmore and Wm. Hopkin Akester, 57, Chancery-lane, London.

2110. **Improvements in the process of treating incandescents.** Carl Dellwik, 46, Lincoln's-inn-fields, London.

SPECIFICATIONS PUBLISHED.

1889.

489. **Autographic telegraphs.** Myall. 8d.
1166. **Testing electric conductors.** . Lowrie and Hall. 8d.
2544. **Secondary batteries.** Douglass and Smith. 6d.
2567. **Electrically driving vehicles.** Elwell and Starley. 8d.
2694. **Electrical resistances.** Goolden and Evershed. 8d.
3402. **Metering electric energy.** Scott and others. 8d.
3844. **Electrical distribution.** Thompson (Westinghouse Electric Company.). 8d.
4875. **Electrical transmission.** Immisch. 6d.
4883. **Electrical switch.** Howard. 6d.
6063A. **Electric spark rupturing appliances.** Lake (Thomson. 8d.
11661. **Thermo-electric batteries.** Huelser (Mestern). 8d.
16148. **Electric couplings.** Studte. 6d.
19892. **Welding metal by electricity.** Fowler. 6d.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Anglo-American Brush	—	2⅝
— Pref.	—	1⅞
India Rubber, Gutta Percha & Telegraph Co.	10	18⅞
House-to-House	4½	5
Metropolitan Electric Supply	—	4½
London Electric Supply	5	3½
Swan United	3½	5½
Telegraph Construction	12	45
— 6%, 1889	100	105
National Telephone	5	5¼

NOTES.

Cracow.—A Vienna firm have obtained the contract for lighting the town of Cracow.

Exhibition at Liege.—A national and international exhibition will be opened at Liege in June, 1890.

Vienna.—A new works for the manufacture of cables has been erected at Vienna by Messrs. Siemens and Halske.

Sprague Motors in Japan.—The Philadelphia agents of the Sprague Company are equipping two street cars for an electric railway in Japan.

Edison-Lalande Battery.—The Edison-Lalande battery is, it is stated, a great success, and over 1,000 cells have been put in use since December.

Electric Traction in Russia.—The tramway company of the Corps Forestier line, St. Petersburg, are intending to replace steam traction by electric traction.

Brussels.—The Société de l'Electricité have addressed a letter to the Communal Council demanding a new award in the distribution of electric lighting concessions for Brussels.

Barnsley.—It must not be forgotten that the time for sending in tenders for the electric lighting of Barnsley, as will be seen from the advertisement, expires on next Friday, 28th February.

Westinghouse Arc System.—The Westinghouse Electric Company has sent a 125-light arc dynamo, Westinghouse new arc light system, to New York City. The machine will run in connection with converters, and the flat carbon lamp will be used.

The Institution.—Mr. Swinburne's paper on "The Theory of Armature Reaction in Dynamos and Motors" read before the Institution of Electrical Engineers on the 13th inst., was discussed conjointly with Mr. Esson's communication on "Some Points in Dynamo and Motor Design" last evening.

Telegraphing Money Orders.—The system of telegraphing money orders seems to have proved a successful experiment, and the Post Office authorities announce that on and after March 1st the system will be extended, and will apply to all offices at which telegraph and money order business is transacted.

Switzerland.—The public electric lighting of the town of Locle, Switzerland, will take place on the 1st March. The work of construction is now being rapidly pushed forward. The motive power is obtained from turbines; the electric plant is being supplied by Messrs. Cuenod, Sautter, and Co., of Geneva. The cost is about £12,000.

Overhead Wires.—The Sanitary and Parliamentary Bills Committee of the St. James's Vestry submitted a report recommending the Vestry to petition against the London Subways and Overhead Wires Bill of the London County Council, with a view to the insertion of clauses for the removal of overhead wires within some period to be specified by the Bill. This was carried.

Kensington Map.—The Kensington and Knightsbridge Company have issued a map of their district with the houses fronting the existing mains coloured red. The map shows a large amount of progress in what is one of the best districts of West-end London, and the issue of a map will no doubt serve to forcibly impress the inhabitants of the useful fact that electricity is now at their very doors.

Central London Electric Railway.—At the St. James's Vestry it was resolved to petition against the Bill of the Central London Railway unless the promoters agreed to the insertion of a clause requiring the company to pay to the London County Council a substantial sum for street improvements in consideration of their being allowed to construct the railway under the public thoroughfares.

Doubrava Direct Current Transformers.—A central station is to be erected in Brünn, by MM. Bartelmus and Company of that town, on the Doubrava transformer system. As the principle of this system of distribution is the employment of direct currents and condensers as reducers of current, the practical result of what would seem an audacious experiment will be awaited with interest by electrical engineers.

Lecture at St. James's Hall.—Mr. George Offor has arranged, in conjunction with the Balloon Society, to give a lecture at St. James's Hall, Piccadilly, this (Friday) evening, "On the Action of Local Authorities and the Board of Trade in connection with the Supply of Electricity." Tickets may be had for any electrical engineers who would like to take part in the discussion, at 21, Budge-row, or from Mr. Offor, 4, Great Winchester-street.

Overhead Electric Railway through Russia.—It is stated that one of the foremost electrical engineers in Russia is a great believer in American methods of electric traction, and also, it would seem, of American vastness of proposals. He has lately proposed to the Czar the erection of an elevated electrical railroad from St. Petersburg to Zaretzin, a distance of 2,000 miles. We have not heard of the Czar's acceptance of this imposing proposal.

The Electric Meter Competition.—A competition for the best types of electric meters has been held, as announced some time ago, at Paris. The result of the examination of the specimens submitted, undertaken by the most competent electricians, engineers, professors, and municipal councillors of Paris, is not yet officially made known, but it is stated that the premium of 2,000f. has been awarded to the Cauderay meter, and that of 1,000f. to the Brillié meter without mentioning the others.

Canada.—A Brush alternating incandescent plant has been installed at Barrie, Ontario, and is remarkable as being the first and only one as yet in Canada using 2,000 volts and transforming down to 100. Canada would therefore seem to be a happy hunting ground for some of our more enterprising electrical engineers. The plant mentioned has been very successful, some 800 lamps having been first connected and a further plant ordered for 1,000 lamps. A waterfall five miles from the town supplies the power.

Halles Centrales.—There is one thing a municipal station should not do, and that is stop working when wanted. This is, however, what happened lately, according to the French papers, at the Halles central station, to the great disgust of the market folk, who had hoped to have done with the gas. Through the negligence of a stoker the boiler pressure fell, and the engine had to be stopped while steam was again got up. The question of introducing accumulators to complete the equipment of the station is being suggested.

Station Lighting.—The company Chemin de Fer du Nord, France, has not been able to arrange satisfactorily with the gas company of Wazemmes, and has decided to erect its own electric lighting apparatus. This decision deprives the gas company of one of its largest customers, for the consumption of the railway company was over five million cubic feet per annum. Little losses such as these are more than a gas company can afford to have continued, and must result in an active state of adaptation to other purposes to keep up the demand.

Artistic Fittings.—We paid a visit to Messrs. Faraday and Sons' showrooms, Berners-street, this week, and inspected a number of new and very pretty electric fittings by this firm. They are very busy with West-end installations, and are preparing a new catalogue of fittings, which, however, will not be out for some time. Those who wish to see the newest artistic fittings should therefore call. While in the district they should also call in and see the additions in new designs of cut-glass electroliers of Messrs. Osler and Co., in Oxford-street, who have some very elaborate and handsome fittings.

Handbook of Medical Electricity.—We have received a copy of " A Handbook for Operators in Medical Electricity," by H. Newman Lawrence, A.I.E.E. (Geo. Gill and Sons). It aims at supplying useful data and hints to nurses who have to work under medical men. It gives instructions in the treatment of batteries, short explanation of terms and instruments, and tables of bones, and diagrams of motor points, muscles, and nerves on the human body. This little book is arranged on a scientific basis, and will serve to enable such benefits as accrue from the application of electricity to the human body to be studied and applied in an intelligent manner.

Zigzag Lightning Flashes.—At the monthly meeting of the Royal Meteorological Society, a paper was read on "An Optical Feature of the Lightning Flash," by E. S. Bruce, M.A., F.R.Met.Soc. It has been stated in the report of the Thunderstorm Committee of the Royal Meteorological Society that there is not the slightest evidence in the photographs of lightning flashes of the angular zigzag or forked forms commonly seen in pictures. The author, however, believes that this is an optical reality, as the clouds on which the projection of the flash is cast are often of the cumulus type, which afford an angular surface. In support of this theory he exhibited some lantern slides of lightning playing over clouds.

Proposed New Atlantic Cable.—A petition has been presented to the Dominion Parliament on behalf of a number of prominent Canadians, asking for their incorporation as the Canada Cable Company. Power is asked to construct, equip, work, maintain, and operate a submarine electric telegraph line, from a point in the United Kingdom, across the Atlantic to a point in the province of Quebec, on the north shore of the St. Lawrence, through the straits of Belle Isle, and to connect the same with the telegraph system of the Dominion. It is said that the proposed company has sufficient capital promised, both in England and Canada, and that as soon as the Incorporation Bill is passed the work of construction will be begun.

Exhibition at the Palais de l'Industrie.—Another Paris exhibition ? It would seem so, though not in the famous Champs de Mars. It is announced that the Société Nationale des Sciences et des Arts Industriels are preparing an international exhibition in the Palais de l'Industrie, which will be open this year from July to November. The eighth group will comprise electrical industries divided into two groups : electricity, which will receive batteries, accumulators, dynamos, and apparatus for employment of electric power ; and telegraphy and telephony, which will comprise apparatus for telegraphic and telephonic communications and allied subjects. The executive offices at present are at 1, Passage des Petits-Peres, Paris.

London County Council Appointments.—At the meeting of the London County Council on Tuesday, the question of the appointments of electrical inspectors was decided. The Highways Committee reported that they had proceeded upon the resolutions of the Council of December 3 last as to certain appointments in the engineer's department, and they recommended that Mr. W. Arnot should be appointed, at a salary of £200 a year, to discharge the duties of an inspector under the Electric Lighting Acts and other duties ; that Mr. A. Champion be appointed at a salary of £3. 3s. a week to supervise the works ; and that Mr. J. Somers be appointed in the engineer's department at a salary of £2 a week. In each case conditions were made that no other work was to be done by the person appointed, nor was there to be any claim for pension on retirement. These recommendations were approved.

Overhead Wires at Glasgow.—The special committee on overhead electric light cables and wires appointed by the Glasgow Council reported that at a meeting of the committee on 7th February the clerk submitted correspondence with the Board of Trade and with Messrs. Muir, Mavor, and Coulson, Limited, in regard to overhead electric wires in the city. On behalf of the Board of Trade, Major Cardew, R.E., electrical adviser of the department, had inspected the installation. Major Cardew reported that this was one of the best installations he had yet seen. The insulated wire used is well up to the standard of regulations, which have been generally complied with, except in a few cases, in which he recommended slight alterations. The committee were of opinion that they had discharged their duty when they called the attention of the Board of Trade to the matter, but it was thought that it might be better that the committee should be continued in order that any questions might be considered. This was adopted, and the committee was continued.

Royal Institution.—Lord Rayleigh commenced a series of seven lectures on " Electricity and Magnetism " at the Royal Institution on Saturday afternoon. Several well-known experiments were performed to explain the elementary facts of the science, and one of these, though not absolutely new, greatly interested the audience, as strikingly exhibiting the remarkable sensitiveness of the spray of water to electrical attraction. A tiny jet produced a miniature fountain, the projected stream naturally, as usual, breaking off into a cascade of separate drops. Lord Rayleigh slightly electrified a rod of glass, and at the distance of probably three yards presented the excited end towards the fountain. Instantly the drops coalesced, and fell in a continuous unbroken line. Yet the same rod, brought close to an electroscope, scarcely moved the gold leaf. When strongly excited the glass rod produced the exactly opposite effect of repulsion, and the falling drops spread out widely. Some such force as the first shown acting between contiguous clouds might go to explain the torrents of rain which often accompany lightning-flashes.

Folkestone.—At the meeting of the Folkestone Town Council last week, the town clerk reported that the solicitors to Messrs. Crompton had applied to the Board of Trade for a provisional order, and it was in course of confirmation. The committee had a letter from Messrs.

Crompton saying that they had been to some expense in applying for the said provisional order, and if the course proposed by the Corporation was adopted it would only be money thrown away. If the Council, they said, would give their consent to the granting of the provisional order they would undertake to consent to its transfer to the Town Council on receipt of £225, money laid out by them. The town clerk then said he thought they would be fettering themselves by doing this. The Mayor remarked that Messrs. Crompton were willing at any time during the next seven years to transfer the provisional order to the Corporation on payment by them of the expenses incurred. The committee were not favourable to a transaction of that kind because they would have to take out a license if anyone applied for the electric light to be supplied to them privately. Mr. Logan was under the impression that the committee had decided to take over the order. The matter was eventually adjourned.

Globe Lightning in a Central Station.—The following remarkable occurrence is reported from the central electric lighting station at Pontevedra in Spain, a report of which has been communicated by Sen. E. Caballero, manager of this station, to the Academy of Madrid. On January 2nd, at 9.15 in the evening, with a clear and serene sky, a globe of fire, of the size of an orange, was all at once observed to fall upon the electric conductors which radiate through the town; it was impossible to say how it fell or whence it came. Along this path it progressed with a relatively slow motion to the central station, destroyed the distributing apparatus, and raising the armature of a circuit-breaker, it struck the moving dynamo. Under the eyes of the engineer and the terrified workmen, it rebounded twice from the dynamo to the conductors and from the conductors to the dynamo, then fell, and burst with a loud noise into a multitude of fragments without producing any accident, or leaving the slightest trace of its mysterious nature. During its evolutions the lights wavered in the town, which would have been plunged into complete darkness if the coolness of the electricians had not allowed them to put everything in order again in a few seconds after the vanishing of the meteor. Several persons had seen the ball of fire before it penetrated to the station.

The Electric Motor in Breakdowns.—Nothing better illustrates the usefulness of the electric motor than its application in an urgent emergency such as the breakdown of the engine in a large printing office. A case of this kind recently occurred in Chicago at the establishment of the John Morris Company, where the boilers exploded, not only injuring several people and doing other damage to the building, but completely ruining the steam plant. To reorganise this would have taken at least a month, involving loss of contracts as well as time. Electricity was therefore suggested and decided upon, and although the accident happened on a Friday afternoon, by Saturday night a 40 h.p. Thomson-Houston motor was installed, and everything was in readiness to start up the great presses, and the work of the establishment, upon the arrival of the men, early Monday morning. This 40 h.p. motor performs its work in every way just as satisfactorily as did the steam plant, and with an entire absence of the danger that in some greater or less degree attends the use of steam boilers, and the other parts of the steam plant. The motor takes up a space of about 2ft. 6in. by 4ft. 6in., it generates no heat, is practically noiseless, and on account of its automatic regulation adapts itself to the load, and runs at the same speed, no matter whether the load on it is 5 or 40 h.p.

Electricity on Board Warships.—A paper by S. Dana Greene, late ensign of the U.S. navy, on the use of electricity on board ships of war, is published in the last quarterly report of the proceedings of the United States Naval Institute. Mr. Greene suggests among other things that the electric motor could replace auxiliary engines on board warships, and enumerates these auxiliaries as follows: Steam, air, and condenser pumps located in engine-room, both for main and auxiliary condensers. Steam pumps for fire purposes, for pumping out the ship, washing decks, etc.; steam reversing engines for each engine; steam-engines for jacking the engines; steam steering engine; steam capstan engines; blower engines for producing forced draught in the fireroom; ventilating engines for ventilating the living spaces below; hoisting engines, under which head are included steam ash hoists and hydraulic ammunition hoists; steam-winches about the decks for lifting heavy weights, swinging out boats, etc.; steam or hydraulic training engines for large guns; steam-engines for driving the dynamos; steam-engines for working lathes, drills, etc., in workshops. Taken together, these auxiliaries will aggregate 40 or 50 engines on a large ship, representing perhaps 200 h.p. The engines, however, are never exerting their maximum power at the same time; hence, if the work were done by motors not over 60 or 70 per cent. of this 200 h.p., allowing liberally, would have to be provided for in the dynamo-room.

The Imchenetzki Battery.—The description is published of a new battery having a considerable E.M.F. and very great constancy, invented by M. Imchenetzki. The exterior containing cell is of tinned iron, with a base of cast iron; the interior cell, open at the base, is of paraffined cardboard and contains eight porous diaphragms. Melted paraffin wax is poured at the bottom of the first cell, and when this is cold the second is introduced. There are thus nine compartments perfectly insulated, of which four contain sulphite of soda with plates of zinc, and the other five are filled with chromic acid with electrodes of specially prepared graphite. The interior cell being a little lower than the exterior cell, two flattened funnels can be placed into the spaces by which the two solutions are poured in. The liquid arrives at the same level in all the compartments. At a certain height openings are made by which the excess liquid can flow through. An outlet is made at the bottom of the first cell by which the whole of the compartments can be emptied by the simple turning of a tap. The positive electrode is in compressed graphite, with a metallic gauze, to which the terminals are soldered and covered with paraffin wax. The graphite is light and very compact, so that the liquid in which it is immersed does not rise by capillary attraction and does not oxidise the terminals which usually happens with other batteries. In certain types the negative pole is also made of graphite. The E.M.F. of this battery is 2·12 volts or 0·8 volts if both electrodes are of graphite; the internal resistance is 0·08 ohms. The battery, when short-circuited in itself, gives a very constant current for several hours without trace of polarisation.

Electro-Harmonic Society.—The next concert of the Electro-Harmonic Society will be a ladies' night, Friday, February 28th, 1890, at the St. James's Hall Restaurant (Banquet Room), at eight o'clock. The following are the artistes: Mrs. R. J. Bishop, Miss Kate Heath, Miss Mary Doughty, Mrs. T. H. Harrison, Mr. Brontë Bramwell, Mr. Ronald A. Scott; violins, Miss Edith Doughty and Mr. T. E. Gatehouse; violoncello, Mr. W. Stepney Rawson;

at the pianoforte, Miss Rawson, Mr. James Swinburne, and Mr. Alfred Izard; musical directors, Mr. T. E. Gatehouse and Mr. Arthur Thompson. Programme.—Part 1: Piano and violin duet, "William Tell" (De Beriot and Osborne), Mr. Alfred Izard and Mr. T. E. Gatehouse; song, "Close to my Heart" (Milton Wellings), Mr. T. H. Harrison; song, "Sunshine and Rain" (Blumenthal), Mrs. R. J. Bishop; pianoforte solo, "Nocturne" (Chopin), Mr. James Swinburne; song, Mr. Brontë Bramwell; song, "Dear Heart" (Mattei), Miss Kate Heath; violoncello and piano, "Scherzo" (G. A. Macfarren) (from sonata for 'cello and piano), Miss Rawson and Mr. W. Stepney Rawson; song, "The Lady of the Lea" (H. Smart), Miss Mary Doughty. Part II: vocal duet, "Oh, that we two were Maying," (Alice Mary Smith), Miss Heath and Mr. Brontë Bramwell; song, "In Old Madrid," (Trotére), Mr. Ronald A. Scott; violin duet, "Fourth Symphonie Concertante" (C. Dancla), Miss Edith Doughty and Mr. T. E. Gatehouse; song, "The Suliote War Song," (B. Richards), Mr. T. H. Harrison; song, "Orpheus with His Lute" (Sullivan), Mrs. R. J. Bishop; violin solo, "*a.* Gavotte (Popper), *b.* Pizzicato (Thomé), Mr. T. E. Gatehouse; song, Miss Heath; trio, "Memory" (H. Leslie), Mrs. R. J. Bishop, Miss Heath, and Mr. Brontë Bramwell. A Broadwood piano will be used.

The Westinghouse Company.—The works of the Westinghouse Electric Company are to be removed from the well-known situation at Pittsburgh, U.S., and new and much larger factories will be erected as soon as possible near Brinton, on the main line of the Pennsylvania Railroad, about 12 miles from Pittsburgh. This removal, says the New York *Electrical Engineer*, is deemed advisable by the directors of the company on account of lack of sufficient space in the present works, and the great cost of enlarging the premises now situated in the heart of the city. The present buildings are to be sold and will, it is thought, yield 500,000dols. This money will be used in the construction of the new shops, which will occupy a plot of 15 acres. It is the purpose of the Westinghouse Electric Company to lay out and build up a new borough surrounding the plant, as is being done at Wilmerding, several miles distant, where the new Westinghouse air-brake works are nearing completion. The Electric Company since a year ago has increased the number of its workmen from 600 to 1,300, and these, with their families, will give the new town a population of about 5,000. The record of the progress of the Westinghouse Electric Company during the year 1889 is very remarkable even in these days of astonishing developments in electrical industries. On the 1st of January, 1889, 132 central station plants had been sold by the company, aggregating a capacity of 240,000 lamps. The number of central station plants has now reached 266, with an aggregate capacity of nearly 500,000 lamps. Meantime the absorption of the Waterhouse arc light business, the manufacture of the Shallenberger alternate-current meter, Tesla motor work, and other additions to the original undertaking, compelled large additions to the Pittsburgh shops and the removal of the lamp factory to New York. The number of employés at Pittsburgh grew from 600 to 1,400. Available space being now exhausted the company wisely adopts, for the removal of its works, a suburban locality which will permit of indefinite expansion of factory room in the future.

Lithanode.—It is a pity there is not a more extended knowledge of the usefulness of lithanode, the new material of which secondary batteries have been made. Apart from its employment in accumulators it is a most useful thing to have about in a technical testing-room. A stick of lithanode, capped with a piece of platinum foil and screwed up with binding screw, makes a very powerful and easily-made electrode for a testing battery, with either a strip of zinc or a scrap of iron—such as a nail or a piece of an old kettle—as the other pole. These can be slipped into a tumbler or wine glass with dilute sulphuric acid of 1·13 to 1·17 specific gravity, (say 1 to 6). The E.M.F. is very high, nearly 2·5 with zinc and about 1·7 to 2 with iron, more or less according to quality, a French nail being the best. Suppose 10 volts is required; five cells would give this, or four with zinc. Slip the lithanode into wine glasses with French nails as the other pole, pour in a little ordinary solution and in the twinkling of an eye almost you have your potential—sometimes a perfect godsend to a student or tester instead of having to set up the ordinary arrangement. The lithanode is being employed mostly for cells for miner's lamps, for which it is proving admirably adapted, the requirements of such a lamp being that it should be cheap, not weigh more than 4lb., and should give a candle-power for at least 12 or 14 hours. Mr. Desmond Fitzgerald, the inventor of lithanode—than whom few have experimented and tested more largely on batteries and kindred subjects—has lately perfected his testing apparatus and laboratory, with arrangements ready set up and connected, so that reliable tests can be obtained at any time within some five minutes, of any combination or battery, to three places of decimals, of the E.M.F. on open circuit, with any given closed circuit, the internal resistance. Mr. Fitzgerald has found that his lithanode is the only substance so far discovered that is not at all attacked by chlorine; even platinum is attacked more or less. Lithanode has a far greater affinity for its own oxygen than for chlorine, a property which makes it the only anode for chlorine.

Edinburgh Electrical Exhibition.—A meeting of the London Committee of the Edinburgh Exhibition was held on Monday at the Mansion House. Sir George Hayter Chubb, in the absence of the Lord Mayor, presided, and there were present Sir Frederick Abel, F.R.S., Captain Shaw, C.B., Baron de Bush, Mr. Philip Scratchley, Major Flood Page, and others. The chairman stated that he had recently visited Edinburgh in order to obtain information as to the progress and relative importance of the exhibition, which would be opened during the first week in May. The site was undeniably a good one, in an open space and a most attractive situation. There were two railway stations in the grounds, and the canal would be used for the conveyance of visitors by electric launches. The exhibition consisted of two large buildings connected by a covered walk. One would contain industrial, art, and general exhibits, and the other the electrical and engineering sections. The grounds would be utilised in various novel and attractive ways. By far the largest proportion of exhibitors would be from England. The space had been applied for twice over, and nearly 100 of the chief electrical firms would exhibit. Several sections would be reserved for foreign countries, some of whom were exhibiting officially. The guarantee fund amounted to £25,410, and though there was every reason to suppose that the exhibition, like those held in Edinburgh and Glasgow of recent years, would result in a surplus, yet it was desirable that the guarantee fund should amount to £40,000. An art section would be added, and also a special railway section, which, owing to the public spirit shown by the leading railway companies, was likely to be attractive. The promised visit of the Lord Mayor to Edinburgh had excited much pleasant interest. Mr. S. Lee Bapty, the general manager, gave particulars of the fine art section, and mentioned that there would be special Post Office exhibits, illustrative of the progress of the postal system during the last 50 years, and there would most likely be an exhibition of police relics. Foreign countries had come forward with fine exhibits, and the prospects of the exhibition as a whole were highly satisfactory. At the instance of Captain Shaw, seconded by Sir F. Abel, a motion commending the movement for the increase of the guarantee fund was adopted, as was also one in furtherance of the interests of the art section. Various guarantees were handed in, and the committee separated.

The Thomson-Houston System for Bridlington. The public lighting of the streets by electricity was discussed before a crowded public meeting of the ratepayers of Bridlington Quay on Friday last, convened in response to a numerously-signed requisition. As already mentioned, at the last meeting of the Local Board tenders were received from the Bridlington Gas Company to light the district with gas as hitherto, and one from Messrs. Laing, Wharton, and Down to light with electricity. The result of the voting was that neither tender was accepted, and as the gas company's present tender terminates on March 26 next, the town will be in darkness unless some arrangement is come to, and the meeting was called with a view of getting an expression of opinion from the ratepayers. Dr. Redman, chairman of the Lighting Committee of the Local Board, said that owing to the manner in which the gas company had treated the Board in the matter of public lighting, the committee recommended that tenders should be obtained for lighting the town by the electric light. The ratepayers were constantly blaming the committee for imperfect lighting, but it was not the fault of the committee, but the gas company. Their contract only allowed them to light 1,200 hours per annum, and they had to light more and less as the case might be. He then proceeded to advocate the adoption of the electric light, and stated that Messrs. Laing, Wharton and Down would light the district with arc and incandescent lamps on the Thomson-Houston system for £900 per annum for five years, and £920 per annum for three years. This would be a marked improvement on the present light, and would do away with all the difficulty and trouble there was in lighting and putting out lamps. He concluded by reading numerous testimonials in favour of this light. He moved: "That, in the opinion of this meeting, the immediate adoption of electricity for public lighting purposes would be a very great improvement, and of great advantage to the ratepayers at large." Mr. H. J. Jackson seconded the resolution, and said he believed the adoption of the electric light would not only be a great advantage in public lighting, but also for private lighting. Mr. Creaser asked Dr. Redman whether he was quite certain the electric light company could properly light the town for £900 per annum. Dr. Redman said they had a good company, and they could bind them to light the town efficiently. Mr. Draffin supported the resolution. Mr. W. O. Jarratt and Councillor W. Pool agreed with the resolution, but did not agree with getting a private company to supply electric lighting. Mr. W. Dobson (a member of the Board who voted against it at the Board meeting) was received with loud hooting and cries of "Inconsistent." He now said, amidst laughter, that he had great pleasure in supporting the resolution. His action at the Board might seem inconsistent, but he thought they were not then in a position to adopt it. But he agreed that the Board should supply it themselves. Other speakers having addressed the meeting, the chairman then put the resolution, which was carried amid loud cheers, only two or three hands being held up against it.

Transmission of Power.—M. Marcel Deprez gives an account of the electrical transmission of power at Bourganeuf, in the Comptes Rendus, the following abstract of which appears in the Institution of Civil Engineers' *Transactions*. The author first calls attention to the partially successful experiments on electric transmission of power between Paris and Creil which he made in 1886, and which demonstrated that 80 h.p. could be transmitted when 165 h.p. was being absorbed by the generator. In these experiments a pressure of 9,000 to 11,000 volts was used, and the failure of completely satisfactory results was attributed to the improper construction of the connecting cable, to defects of organisation, and want of experience now available. This year, however, the authorities of the town of Bourganeuf decided, if possible, to utilise the power of a waterfall on the Maulde, situated 1,100 yards from St. Martin-le-Chateau, and 8¾ miles from Bourganeuf, and the work was entrusted to the Société pour la Transmission de l'Electricité, engineered by the author. The fall utilised is about 100ft., and develops 130 h.p. in a horizontal turbine making 150 revolutions per minute. The generator is a high-tension dynamo having two armatures on the same shaft in series with one another, of the form known as the Deprez model. The electrical details of each armature are as follows: Resistance two ohms, diameter of wire two millimetres, allowing for the armature a total current of 35 amperes. The machine is separately excited, the magnets absorbing 90 volts 20 amperes, rather more than 2 e.h.p. The line is double (out and return wires), composed of bare silicon bronze wire five millimetres diameter (about No. 6 B.W.G.), carried on porcelain insulators, giving an insulation resistance practically infinite even after prolonged rain. The total resistance of the line is 23 ohms. The motor is identical with the generator, and is excited by part of the current from the dynamo used for the illumination of the town, whilst to start the motor the current from a set of accumulators is used. The actual lighting machines are Gramme dynamos. Experiments with an artificial line having a resistance of 25 ohms gave the following results: E.M.F. at generator terminal 3,550 volts, current 20 amperes, the E.M.F. of the lighting machines being 115 volts, and the current 376 amperes, taking the efficiencies of the low-tension dynamos at 80 per cent., and the high-tension machines (as experiment showed) at 90 per cent. This experiment proved that 60 h.p. could be developed at Bourganeuf by an expenditure of 100 h.p. at St. Martin. The actual working of the machines has proved admirable. The regulation is effected by a pure water liquid resistance, and by a code of signals from the motor attendant to the attendant at the generator station. In a month there was only one stoppage of the generator, and three of the motor, principally due to the inexperience of the enginemen. Particular precautions have been taken to avoid damage to the machinery from lightning discharges from the line, which appear to have been successful, but the methods adopted are not described by the author.

HOW TO PRODUCE ELECTRICAL PRESSURE.*

(Continued from page 128.)

DYNAMOS.

The Modern Dynamo.—The reader must consult larger books to obtain a knowledge of the history of the development of the dynamo since Faraday first published his experiment upon the interaction of conductive and magnetic circuits. A long roll of names will be found of men who have designed apparatus or investigated theories, each adding to our knowledge of the subject. The men, however, who have done most to perfect the modern dynamo are Hopkinson and Kapp, in that their investigations have enabled us to work by rule, to specify and to obtain that specified—not only to tell what a dynamo will do after it is made, but to tell what it will do before it is made. Others have added lines to their pages, and rounded off some of the corners of their investigations, but these men stand far before all others in the matter of obtaining results capable of being practically used to construct machines. Before entering upon the consideration of the dynamo it will be necessary to prepare the way. Hitherto the formulæ used have been exceedingly simple, involving really only a little arithmetical knowledge. It is desirable, however, that the student should understand something of graphical formulæ, and although a full knowledge of these would involve an acquaintance with higher mathematics, no such knowledge is required in this elementary work.

Electro-Graphics.—The ancient Assyrians and Egyptians used a hieroglyphic literature, so does the modern scientific man. The latter uses lines and curves to represent many things, and frequently a line or curve rightly interpreted will speak more clearly and more plainly than many pages of type.

A point is used to indicate a certain position in space. From a point or to a point a line may be drawn, and this line will indicate magnitude as well as direction. Thus we may indicate a force as acting at the point O in the direction of OX, and if the force is of so many pounds or tons, the length of OX can indicate how many pounds or tons. If we agree that a certain length shall indicate one pound or one ton.

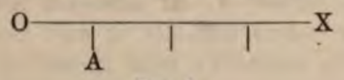

FIG. 8.

Thus, if OA represents one pound OX will represent four pounds, if OA represent one ton OX will represent four tons. Instead of one force acting upon a body at the point O in the direction and of the magnitude OX, there may be two or more forces acting at the point in the same or in other directions. For example, we may have a force in the direction OY at right angles to OX, similarly represented in direction and in magnitude by OY.

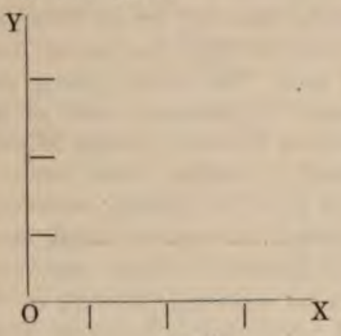

FIG. 9.

If two forces act upon a body at O the body will not move in the direction of either of those forces, except the direction in which they act is in the same straight line. Thus, if two forces, A and B, act upon a body at O in the direction shown by the arrows, and of magnitude proportional to the lines, the body will move or tend to move in $\overset{B}{<\!\!-\!\!-\!\!-\!\!-}\,O\,\overset{A}{-\!\!-\!\!-\!\!->}$ the direction OA. If the forces are not in the same straight line, but act at any angle, the body moves or tends to move in a direction somewhere between the direction of the forces. If the two forces are constant in direction and in magnitude, the resultant direction in which the body moves or tends to move is a straight line. This line, when obtained, is said to be "the resultant of the forces." Its direction and magnitude in the simple case mentioned, that of forces acting along OX, OY, and of the magnitude OX, OY, can easily be obtained by completing the parallelogram, of which OX, OY form adjacent sides, and drawing the diagonal OZ. Then OZ is the resultant in magnitude, and in direction of the forces OX, OY acting upon O at the point O in the directions OX, OY. Similarly the resultant of any two forces can be found by drawing the diagonal of the completed parallelogram. If the forces are not constant in direction or in magnitude, then the direction of the resultant will probably be a curve. Thus we see how lines and curves can be utilised to indicate the direction and magnitude of forces, and the "resultant" of forces in magnitude and direction.

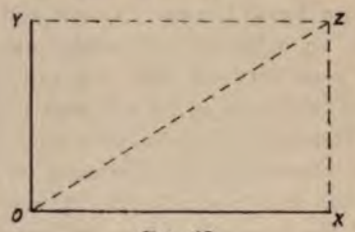

FIG. 10.

The position of a point is determined when we know its distance from three plane surfaces. It is sufficient, however, in diagram, when both lines and points are the plane of the paper, to determine the position of a point by its distance from two lines. For diagrammatic or hieroglyphic purposes the lines to which the distance is referred are generally at right angles, as XOX_1, YOY_1. The exact position, then, of a point P is determined if we know its distance from XOX_1 and YOY_1. But another convention comes in: all positions to the right of YOY_1 are termed positive as regards YOY_1, similarly all positions above XOX_1 are positive as regards XOX_1. Now a point P may be in either of the four quadrants as P, P_1, P_2, P_3. Suppose we know P is x inches from Y and y inches from X, we can measure off x inches along OX and y inches along OY, and from these points draw lines parallel to OX and OY respectively. Where these lines intersect will be the point P. If the distance be $-x$ and $+y$ we know the point is in quadrant X_1OY; if $-x$ and $-y$, in quadrant X_1OY_1; if x and $-y$, in quadrant XOY_1; and thus the position of a point is fully determined. The lines OX, OY are called axes, O the origin of the axes, x and y are called ordinates; y is called *the* ordinate and x the abscissa of the point P. Usually in simple cases only one quadrant is required, YOX. It will at once be seen that if we can determine the position of one point we can determine the position of any number of points, and a succession of points will produce a straight or a curved line. Experimental and constructional work frequently requires the determination of a number of points. Joining the points gives lines and curves from which information can be deduced, and sometimes laws obtained. Let us take a practical example. When a piece of iron is subjected to magnetic pressure, it is said to be magnetised—that is, it has a certain number of lines of force, or lines of induction, sent through it as previously explained. If, then, equal parts of OX are taken to represent equal additions of magnetic pressure, the number of lines in the iron will increase with the increase of pressure.

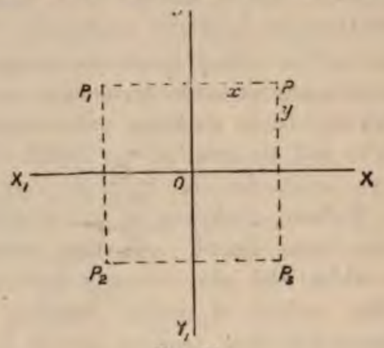

FIG. 11.

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* Extracts from "First Principles of Electrical Engineering."

Equal distances along OY can be taken to represent equal number of lines of force. Thus the magnetism due to pressure a is seen to be a_1, due to pressure b is b_1, to pressure c is c_1, and so on. If the divisions of OX,OY represent numerical values, as they are usually made to do, a large amount of information is graphically put into a small space. The placing the points c, c_1, c_2, etc., obtained by the experiment, and subsequently joining the points, is called plotting the line or curve. Ruled paper for the plotting of such curves can be obtained at almost any stationers.

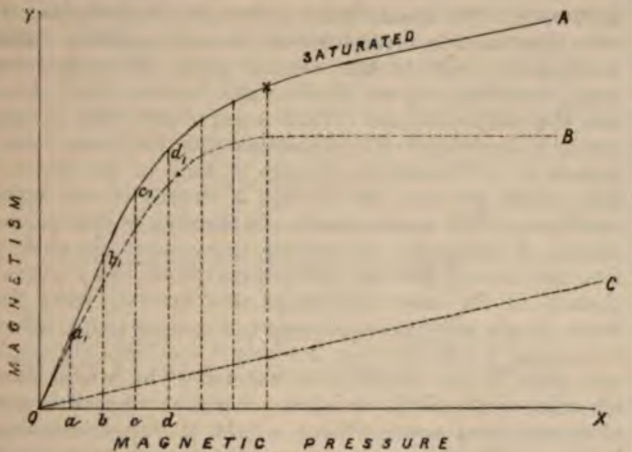


FIG. 12.

Principles of the Dynamo.—The broad features of the modern dynamo, those to which it owes its utility, are the interactions between the magnetic and the conductive circuits. Usually a conductive circuit is placed in and revolved in a magnetic circuit. The magnets used to obtain the magnetic field are called the field-magnets; that part of the conductive circuit revolving in the field is called the armature. It has been stated that the action in the conductive circuit is proportional to the number of loops, or closed curves of lines of force that pass around it due to the magnetic field. According to the views expressed in previous chapters, it will be found that the action of placing magnetic loops around a conductor is to diminish the electrical pressure in that part of the conductor so placed, and this diminution of pressure leads to a flow of current in the conductor. It will easily be seen that the placing of a number of loops around a conductor leads but to a momentary current; if we increase the number of loops, further current in the same direction is set up; decrease the loops, and the current flows back and it is in the reverse direction; get rid of all the loops, and the current goes back altogether, and the conductor is in its normal state. Take a conductor, R, of a single turn, and place it in a magnetic field as in Fig 13.

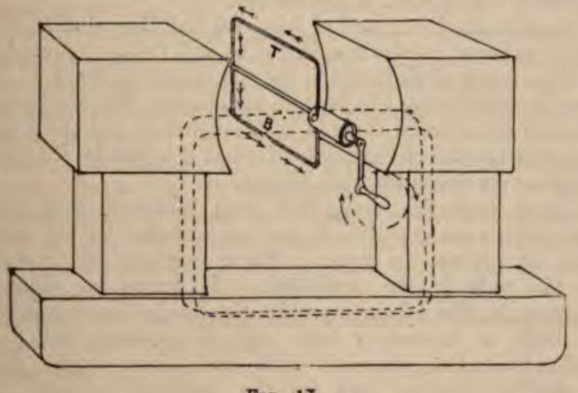


FIG. 13.

Assume the direction of the loops to be from the pole N to the pole S. When the conductive circuit, R, is in a vertical position, the maximum number of magnetic loops due to the magnetic field, N S, pass around the lower portion of the circuit R, and there is in that part of the circuit a diminution of the electrical pressure, and a current is momentarily set up in the direction shown by the arrows. Turning the handle, H, in the direction of the hands of a watch, as shown by the arrow, so that R passes through a quarter of a revolution, the conductor then has the minimum number of loops passing around it, and in the revolution there has been a gradual diminution from the maximum number to the minimum, and as a result there has been a current in the reverse direction to the original current. Turning the handle another quarter of a revolution, that part of the conducting wire that was originally at the top, T, is now at the bottom, B, and has now the maximum number of loops around it, and the current will be the direction of the arrows—that is, just in the opposite direction to what it was when this part of the circuit was the top member of the system. The action through the whole revolution may be illustrated thus. Let the line AE represent the motion of the handle. AB representing first quarter revolution, BC the second, CB the third, and DE the fourth. Suppose the circuit RTB at the start horizontal—that is, with minimum or no loops around it—the bottom member, B, being at the right-hand nearest to the pole N of the magnet. Directly the handle begins to move, loops are formed around B; the number of loops increase till the circuit is vertical. During this time the current in the circuit increases from its minimum to its maximum. Passing the vertical point, the loops around B diminish till the horizontal point is reached, when B is nearest the pole S. Passing this point, the loops begin to be formed around T, and a similar action to what has just been described happens in regard to T, the current rising from the minimum to the maximum, and decreasing again to the maximum. If F represents the maximum current, AFC, CFE will represent what goes on as regards current in the circuit. It is almost exactly that of the ebbing and flowing of the tide. The number of loops around the wire determines the electrical pressure at that point, the pressure being least with the greatest number of loops, and returning to the normal state with no loops.

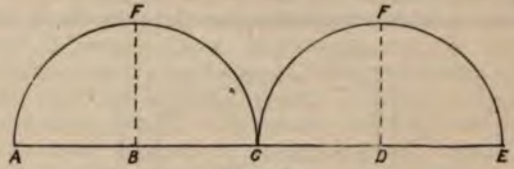


FIG. 14.

It will be seen then that one of the most important questions connected with dynamos is the number of loops that pass around the conductive circuit, as this determines the electrical pressure, and consequently the current. We have preferred to speak hitherto of loops, or the closed curves, as this seems more in accordance with facts, than of so many lines of force passing through the space enclosed by the conducting circuit. Passing through gives no reason for any alteration of electrical pressure in the circuit—passing round does—and that is the difference between us and previous writers. If we consider T as part of a complete circuit, we must then consider that during one half revolution current flows in one direction, and during the other half it flows in the other. This may be represented as in Fig. 15, though in many machines arrangements are made that the current in the external part of the circuit shall always be in the same direction. These machines are called continuous current, while those in which the current is not so commuted are called alternate-current machines.

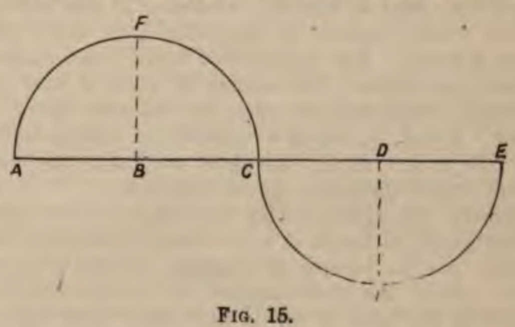


FIG. 15.

If, instead of assuming that the electrical pressure is diminished in proportion to the number of encircling loops, it is assumed that the pressure at another point in the circuit is increased in that proportion, the result will be the same—

a current will be set up proportional to this pressure. The unit of electrical pressure is, as has been stated, a VOLT, and by the interaction of magnetic and conductive circuit we have means of :—

Obtaining the Pressure.—A volt pressure is obtained by looping around a conductive circuit 100,000,000 loops or lines of force *per second.* We have seen that the pressure with batteries is increased to the required point by adding cell to cell in series. A similar action occurs in the interactions now under consideration. If we place loops around different parts of the same circuit, the total electrical pressure obtained is the sum of the separate pressures. Instead, therefore, of using a circuit of one wire, it is customary to use circuits of a number of turns of the same wire. Thus, in Fig. 16, if we have three turns around which the loops are passed, the pressure obtained is three times that which would be obtained by one turn with the same number of loops round it. This is not exactly the case, as the interactions between the turns themselves tend to somewhat reduce the pressure, as will be seen further on, but for the present we may take the pressure as proportional to the number of turns.

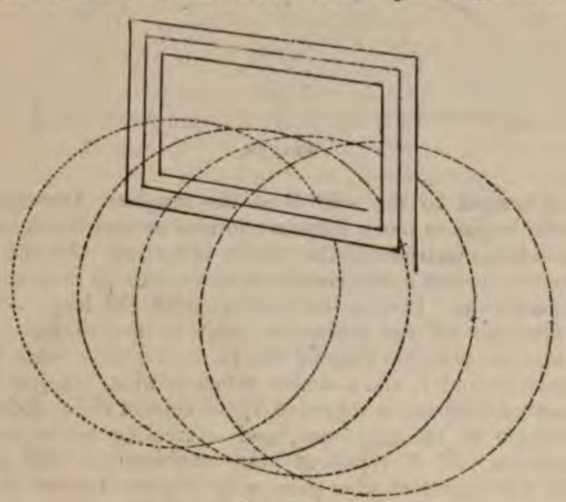


FIG. 16.

Again, as the pressure obtained depends upon the number of loops put around the conductor per second, the faster the turns are revolved the greater will be the pressure obtained. Thus the number of loops around the conductor per second can be increased in various ways.

1. By increasing the intensity of the magnetic field—that is, increasing the number of loops per square inch.
2. By increasing the size of the field, and having a longer total length of conductor acted upon.
3. By increasing the number of turns in the armature coils or so winding that a greater number of turns are acted upon.
4. By increasing the number of revolutions per second.

In practical work it is impossible to carry any of these methods to extremes. Just as a conductor must not be used to carry too great a current, otherwise it will melt, so it becomes a costly process to magnetise iron much past the saturation point. Too large a field would mean cumbersome and heavy machines. The number of turns of wire depends on several considerations—such as size and space to be utilised. Speed is merely a question of mechanical conditions. But even with only the above conditions prevailing the different combinations are almost unlimited.

Obtaining the Field.—The field-magnets are generally electromagnets, although in a few cases, for example, M. De Meritens, uses the permanent magnet. The advantage is all on the side of the electromagnet, for the intensity of field obtained by the latter is far greater than with the former. Attention here will be directed exclusively to dynamos with electromagnets. The electromagnet consists of two parts, the core and the coil. The current in the coil determines the magnetic pressure, while the core determines the resistance of the magnetic circuit. The less the resistance of the core and the air space between its poles, the greater the number of closed lines of force obtained. The great want of to-day in practical work is a practical unit whereby to measure the number of lines of force. Every action of a magnet depends upon "number of lines" involved in the action. If a current in a conductor is required, it is proportional to the number of lines or loops around it. If a pull upon an armature is required, it is proportional to the number of lines passing through it as part of the magnetic circuit. It is as simple as ABC if mathematicians and theorists had not thrown an almost impenetrable veil over the matter. The unit of the theorists is unworkable; it is one line through one square centimetre (·155 square inch). Now, in the first place, not one workman in five hundred knows anything about centimetres; and in the second place, the unit is too small, involving figures of abnormal length. And this is how the unit is obtained. Take a coil of one turn of wire, having a diameter of 10 centimetres (3·937in.), and send a current of 7·9578 amperes through it, then at the centre of that coil we get one line through a surface of one square centimetre (·155 square inch). In English workshops, and outside of pedagogic schoolrooms, measurement is made in feet and inches, but the pedagogues throw every possible obstacle in the way of ordinary men knowing what they mean, for the sole purpose, it seems, of making people believe the subject is difficult when in reality it is exceedingly simple, and could, if put properly, be understood by almost every schoolboy in the sixth standard. Examine what this style of measurement means. Take a field of "unit intensity," that is, a field wherein one line passes through every square centimetre (·155 square inch). A square inch equals 6·4514 square centimetres, so that if we, as ordinary men would, reckon in square inches, 6·4514 lines of force or closed curves pass through every square inch section of the field. Take a conductor with dimensions 18in. by 12in., Fig. 17. We enclose 18 × 12 × 6·4514 lines or curves of force = 1393·5024, or this number of closed curves passes around the bottom member, B, of the field. To get 1 volt pressure we have to enclose 100,000,000 such curves per second, so the number or revolutions per second must be $\frac{100,000,000}{1393\cdot5024 \times 2}$, or over 35,000 revolutions per second.

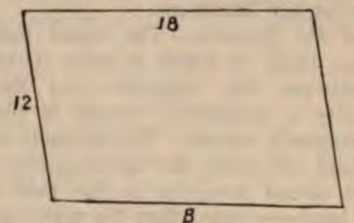


FIG. 17.

Of course, the intensity of the field is always far greater than this, say, 20,000 turns—that is, 20,000 lines pass through the square centimetre (·155 square inch), or 20,000 × 6·4514 = 129,028 lines per square inch. The number of revolutions per second to get one volt now becomes only 1·75, reducing the number of revolutions.

If, instead of one turn of wire, we had fifty similar turns, the number of revolutions would be still further reduced.

The reason of multiplying the denominator by 2 in each case is that the top and bottom members of the turn have the loops of force round them in each revolution, and the pressure generated is therefore double of what it would be if only one member per revolution was looped.

These examples show that long numbers, even if the calculations are not difficult, are necessitated by the absurd unit at present in vogue. These remarks apply simply to the unit in the workshop. It serves an admirable purpose in the laboratory. In the conductive circuit there is both a laboratory unit and a practical unit. The "ohm" is the practical unit, and there ought to be a similar practical unit for the magnetic circuit. The best proposal in this direction has come from Mr. Gisbert Kapp, whose practical unit is 6,000 times greater than the one above defined. Therefore, in the above examples, instead of 129,028 lines, in Kapp's units we get $\frac{129,028}{6,000} =$ 21·5; and according to ordinary methods of thought the figures 21·5 are far easier to manipulate than 129,028. In Mr. Kapp's unit he takes into account, too, the ordinary engineering method of counting revolutions per minute instead of revolutions per second. So far as possible, then the examples in this book will consider the ordinary ways of working and adopt the Kapp unit. Another step is urgently needed—in the production of sets of magnetic resistances, like sets of conductive resistances. Manufacturers could then take a piece of iron, from the bulk, of certain length and sectional area, wind it with a certain number of ampere-turns, and balance it against a standard resistance, issuing the bulk of iron as having a certain magnetic resistance per unit length and unit section. The magnetic resistance of any length and any section would then be known; for just as with conductors, the resistance varies directly as the length and inversely as the sectional area—that is, double length doubles resistance, double sectional area halves resistance.

(*To be continued.*)

CORRESPONDENCE.

COAD'S BATTERY AND MINER'S LAMP.

To the Editor of The Electrical Engineer.

Sir,—Will you kindly permit me, a constant reader of your valuable paper, as one knowing something of coal mines, from a frequent mile or more walk in the underground roads, to offer a few remarks on the above subject for the benefit of whom it may concern. To start with, the weight—5lb.—is just double what is allowable (I say this from what I have been told by experienced mining engineers), to find general favour with those who would use the lamp.

Then comes that very important factor—working cost. Zinc and solution under 2d. per shift of eight hours; this is according to a professional chemist's computation. I imagine in practice, allowing for waste zinc ends, carriage of solutions or chemicals, etc., it will come to at least 2½d.; lamp renewals, say, ½d.; interest on capital expenditure and repairs, say, ½d.; making 3½d. in all. The present cost for lamp and oil varies, but the average will certainly not exceed 1d. per shift.

Now, sir, as colliery owners are not, as a rule, rapidly making their fortunes, they can hardly be expected to nearly quadruple their expenditure for lighting—to raise it from, say, £200 to £750 per annum.

Secondary batteries may, I believe, come into use for miners' lamps in the near future, but for primary—well, we need some discovery yet, so far as I know, undreamt of by the practical man before they can be of general utility for this purpose.

If Mr. Coad had called his lamp the surgeons' and dentists', instead of miners' lamp, I could have welcomed it as likely in the hands of a small (very small) company, or better, a good private firm, to become a practical commercial article. The fact of having only one solution, and being able to run continuously when required, and being moderately cheap to work, would be in its favour.

But what strikes me most in Mr. Coad's letter is the paragraph respecting candle-power. Mr. Coad, by his lens, seems able to repeat the miracle of the loaves and fishes in but slightly altered form, "which I claim *increases the nominal candle-power 2,000 per cent.*" The italics are mine. Let us hope that perpetual motion is nigh.

Apologising for occupying your space, and thanking you in anticipation.—Yours etc.,

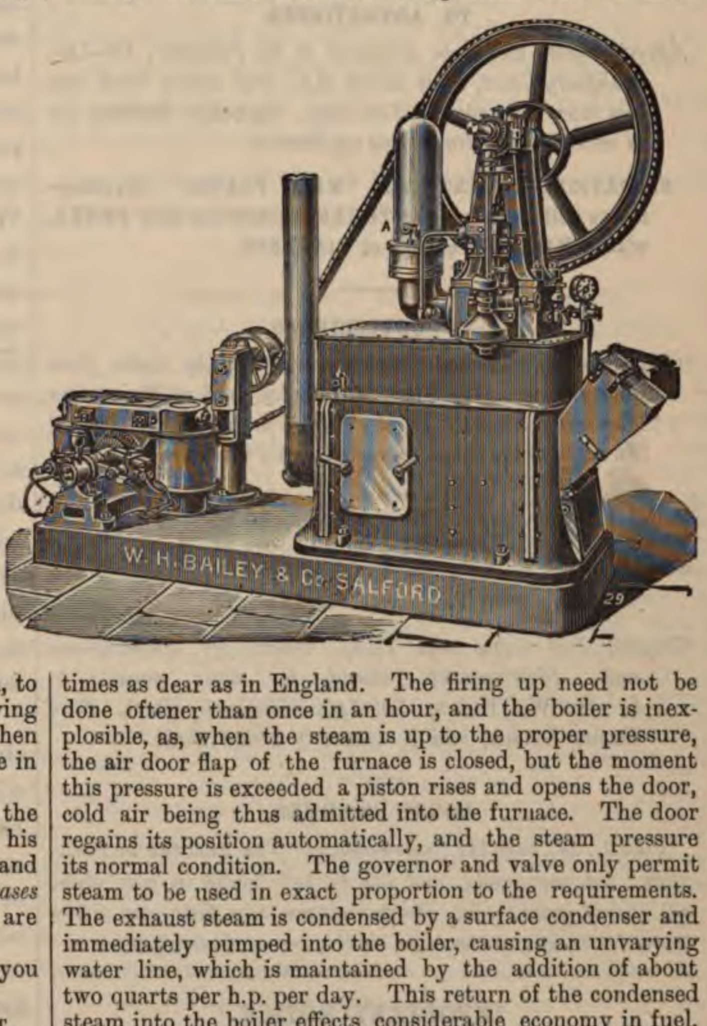
Leeds, Feb. 15, 1890. A. W. Bennett.

To the Editor of the Electrical Engineer.

Sir,—The same old story. *One penny* per hour is the cost of running a primary battery, *one penny* is the cost of the zincs, and *a shilling* a gallon is the cost of the *secret* solution. Such assertions, based on no scientific figures, will not "go down" with the public nowadays. In Dr. Redwood's report of Coad's primary battery it says: "The secret solution cost something under 1s. per gallon! and that a reduction of 20 per cent. may be made by utilising the residuum of the battery! A six-cell battery for twelve hours' *production of light* may be stated at from three halfpence to twopence." There is no mention of the *size* of the battery, *how much current* was taken out, or *how much light* was produced. These facts I suppose must remain as *secret* as the *secret solution*. Until such data are given, the report is worse than useless, and leads one to think there are details that will not bear investigating. I do not think the scientific world, or even the public, will be "had" over the lens that multiplies the light 2,000 per cent. Mr. Coad has evidently been trying to bring out a useful form of battery, and should he succeed, he will be a benefactor to his race. J. G. S. C.

THE BAILEY-FRIEDRICH STEAM MOTOR.

Some interesting particulars were given of the Bailey-Friedrich steam motor upon a visit of the members of the Arts and Brazenose Clubs, Manchester, to the Albion Works, Salford, at the invitation of Alderman Bailey. The motor was shown in working applied to driving a dynamo for incandescent lamps. The motor works without waste of exhaust steam, occupies an exceedingly small space, and requires the minimum of fuel and water supply. The economy observed in fuel, and the fact that almost any kind of refuse can be burnt in the furnace, have already secured several continental orders for the new motor, fuel in Spain, France, and other countries being often twice or three times as dear as in England. The firing up need not be done oftener than once in an hour, and the boiler is inexplosible, as, when the steam is up to the proper pressure, the air door flap of the furnace is closed, but the moment this pressure is exceeded a piston rises and opens the door, cold air being thus admitted into the furnace. The door regains its position automatically, and the steam pressure its normal condition. The governor and valve only permit steam to be used in exact proportion to the requirements. The exhaust steam is condensed by a surface condenser and immediately pumped into the boiler, causing an unvarying water line, which is maintained by the addition of about two quarts per h.p. per day. This return of the condensed steam into the boiler effects considerable economy in fuel, and by the absence of incrustation the life of the boiler is considerably prolonged. It is found by actual test of one of the motors in driving the electric light in the offices of Messrs. W. H. Bailey and Co., Limited, that a No. 2 motor working from 3 p.m. to 9 p.m., and driving 40 16-c.p. lamps, fed with coke, requires starting with 50lb. of fuel, which is supplemented at regular intervals by 25lb., 20lb., 20lb., 20lb., or a total of 135lb. With the cost of fuel at 4d. per 112lb., this gives an expenditure of about 1d. per hour. It gives a very steady light and proves itself a useful motor for small installations.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IMPORTANT NOTICE.

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Specimen copies of the paper will be sent on request.

BAD WORKMANSHIP.

Major Flood Page has in his letter, indited to the *Times*, which we reprint elsewhere, re-echoed the opinions expressed in these columns again and again that danger from electric lighting arises almost entirely from bad and slovenly workmanship. It seems, according to the letter referred to, that a triumvirate was appointed to make a statement to the *Times* on behalf of the industry generally. Various causes contributed to make a joint letter impossible, but there is no reason to doubt but that Major Flood Page has expressed the sentiments of those who were to have been his colleagues. We had a pathetic letter addressed to us the other day by a gentleman interested in introducing the electric light to a flourishing town. "Aid me," said the correspondent, "in giving exact details as to the accidents from electricity in England, and at the same time give a list of all the accidents that have arisen through the use of gas during the same period." He went on to say that the opponents to electric lighting were inundating the townspeople with tales of the dangers of electricity, drawing, however, all their information, and possibly their inspiration, from American sources, or from English journals that seem to be bought body and soul by parties interested in the propagation of these tales. We have said before, and we say it again, that it is a disgrace for such papers as the *Daily News* and the *Standard* to publish the telegrams that often appear without a word of qualification or explanation. There is no possibility of controverting a falsehood, and a falsehood that contains a half truth is still more difficult to tackle. These spicy paragraphs and gruesome stories tickle the palates of many individuals, who, struck with them, tell them to their friends and acquaintances all round, but the chances are all against their seeing a contradiction or explanation, and if they do they will not take the same trouble to spread the true as they took to spread the false impression.

Major Flood Page has justly called attention to the fact that the majority of accidents—some of which accidents have occurred, while some stated to have occurred have not—are confined to a particular area. He concludes that this being so, no argument for or against the safety of electric lighting ought to be based upon what occurs in this area, for it is evident that the work is radically unsound. No one argues upon the danger or safety of the manufacture of explosives from accidents which occur in places where every employé smokes, or open fires or lights are allowed. If a person puts a lighted brand into gunpowder, and gets hurt as the result, no one would argue because of this that gunpowder ought not to be produced. A fool is ofttimes rewarded according to his folly, and no one complains. If, then, people will persist in using methods and materials known to be unsafe, and admitted to be unsafe, we contend that no sane person ought to make a sweeping generalisation upon such premises.

Given a huge medley of electric light wires, telephone and telegraph wires; no real supervision; wires overhead or underground, wires intermingled in any degree of confusion; every company owning or wanting wires fighting for its own hand and careless of what becomes of its neighbours—why should anyone be surprised at accidents? The procedure courts accidents, and it would be a miracle if there were no accidents. An electric spark will dash aside a little gunpowder without ignition, but we would prefer anyone other than ourselves to try the experiment when the pinch of powder was in the centre of a barrel of powder. We should expect if we did it to find the girl who used to light the fire with kerosene, somewhere in space, and we cannot comprehend why a fatal accident trying such an experiment should cause a sensation, no more than we can understand why sensational reports from New York about the dangers of electric lighting should be taken as a proof that "properly carried out such lighting is unsafe."

It is not so; properly installed electric lighting is the safest of all artificial illuminants. A careless student drops an oil lamp and a university is burnt down, at a drunken carousal a lamp is knocked over and a block of buildings is destroyed and several lives are lost. Why have we not had sensational paragraphs against the use of oil?

Major Flood Page points out that electricity is distributed in two ways, under high or under low pressure. While we have never departed from the view that a continuous current under a moderate pressure will ultimately prevail, it is because we think it best suited for the distribution of power as well as the distribution of light, and from no idea of greater safety. The electrical engineer knows, but the ordinary householder does not, that both systems distribute at the same pressure in the house, and the same conditions of safety apply. If we take Ferranti's high-pressure system, and supposing he generates ten thousand volts pressure, this pressure only exists in the grand mains, which should be absolutely closed to prying eyes or fingers. At the transforming stations, equally out of everybody's reach, this high pressure is transformed down to two thousand, and this is the pressure in the ordinary street mains, which again should be out of reach. At the houses it is transformed down again to a harmless hundred volts. It has been said that perchance the pressure of two thousand will get into the house mains by contact somehow of the primary and secondary of the transformer. There is no difficulty here. If, with the existing transformer, such a thing is possible, it is easy to make a transformer where it is impossible.

The popular outcry, however, is directed against low pressure, or at least medium pressure, for this it is that exists in America, therefore as yet the questions involved by the use of such high pressures as the above are not debated. The whole matter comes simply to this, in a district where everything is done to make accidents easy accidents do occur, whence it is argued that the operation anywhere is dangerous. Is it not as good to say that in ninety-nine per cent. of places wherein electricity has been installed no accident has arisen, therefore it is almost absolutely safe? The letter to the *Times* was written because of a fire, and to allay any disquieting feeling of insecurity. At the time of the fire we wrote on this subject very much in the same strain as Major Flood Page has now written. There is, however, one phase of the case which may appeal to the householder. Danger from gas is generally because of a leak, danger from electricity is also generally caused by a leak. The former is odorous, and announces itself, the latter is not odorous, but it may be made to announce itself. It will, perhaps, be well if, when installing the electric light in any house, the contractor was to give the householder or some competent person a few hints on this subject. It should be stated, however, that while every leak of gas is dangerous, it is seldom that a leak of electricity is dangerous.

THE LAW OF INVERSE SQUARES.

To THE EDITOR OF THE ELECTRICAL ENGINEER.

SIR,—On reading your leading article on this subject in the *Electrical Engineer* of February 14, I found in the last paragraph that you had chosen my professor for an example. You were, however, rather unfortunate in your selection, for he is, I believe, the most practically trained of all the electrical engineering teachers in the kingdom, as may be seen on reference to the biographical section of the "Electrical Trades Directory," or in a letter of his on "Training for Electrical Industries" in last week's *Electrician*. The set of questions from which you quote is professedly intended for a theoretical class of students reading up for the advanced examinations of the Science and Art Department. If you look at the electrical engineering questions by the same compiler you will find them sufficiently practical to meet with even your approval; in fact, I know of no one who detests theoretical mathematical investigations, that are not of immediate practical use, more than this same professor of whom you make an example. There seems to be a universal grumbling at the present time against professors and their teaching; but for that teaching electricity would have remained a science, and never have become an art.—Yours, etc.,
A. H. ALLEN.

Arlington-place, Glasgow.

[Mr. Allen's letter requires a reply from us. Why, however, he makes this paper a medium for a gratuitous advertisement of another paper is more than we understand. Neither biography nor letter have anything to do with the subject in hand. Our original remarks were made upon a reference to the South Kensington examinations. It is admitted that our "examples" are from a compilation made to assist these examinations, and our contention is that both examinations and questions are not up to the standard of the practical requirements of the day. If those in connection with the department who do know better, as Mr. Allen says his professor does, were to refuse allegiance to antediluvianism instead of pandering to it and writing books for it, the remedy would soon come; but what can we say of men who waste days and months preparing pupils to pass examinations when they know the information imparted is to be forgotten as soon as possible when the students come into practical work?—Ed. *E. E.*]

THE THEORY OF ARMATURE REACTIONS IN DYNAMOS AND MOTORS.*

BY JAMES SWINBURNE

(Continued from page 135.)

If the cross current-turns are alone considered, a disposition, roughly, as shown in Fig. 7 is obtained. There are no lines across, so the lines are cramped together where they leave the armature only. If Figs. 6 and 7 were superposed, the opposite inductions would be equal quite close to the leading pole corners. The exact position would be difficult to determine, but by such a rough method as that just described the position can be found so as to make no sensible error in the calculations. Fig. 8 shows the disposition of the induction due to the back current-turns. Those going right round the field are left out, for their disposition is almost exactly the same as that of the field lines, and they are cancelled by some of the series winding. If Fig. 8 is superposed on Fig. 6 or 7, the induction is increased on one side and decreased on the other. On each side of the centre line the addition or subtraction is uniform. It is clear, then, that except in the case of very small machines, or machines with very light loads, the position of non-sparking of the brushes is close under the leading pole corners. In practice, this is easily verified by taking two pilot brushes and a detector, and finding the position of no deflection when one is slightly in advance of the other.

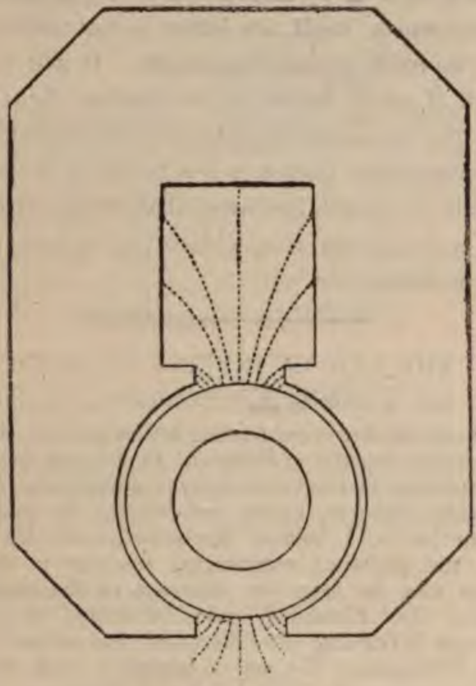

Fig. 7.

A glance at actual machines shows that the conclusion here arrived at theoretically—that the brushes are almost under the leading pole corners—is correct. The angle of lead of brushes at full load thus depends on the pole angle, and the back potential, Ω_b, can now be given in the form $\pi - \theta) n\,C/10$.

Equation (5), for the full load excitation, can therefore be written

$$\Omega_{a-m} = l_a B_a/\mu_a + (\pi - \theta)\,n\,C/10 + g\,B_g + l_m\,B_m/\mu_m \quad . \quad (8)$$

Equation (2), for the cross-sectional area of the field-magnets also becomes in full—

$$A_m = 2ab\frac{B_a}{B_m} + r\frac{l\,B_a/\mu_a + g\ B_g + (\pi - \theta)\ n\ C/10}{M\,B_m} \quad . \ (9)$$

Probably the greatest problem that still remains to dynamo makers to grapple with is that of lessening or avoiding sparking at the brushes. At present it is necessary to move them whenever the load of the machine is altered. Several methods of moving the brushes automatically have been proposed, and perhaps used, in the United States, but they have not come into common use in this country. An attendant is therefore necessary if the brushes are to be kept in good order. Fig. 9 shows a few turns of a winding specially designed to need very little moving of the brushes. A convolution, instead of being wound over the armature diametrically as usual, is wound over the core, so that one side of it gets into the field just as the other side is coming out. At no load, the convolution is commutated when the sides are at equal distances from the pole-pieces. At full load, a very small movement of the brushes is enough to bring one side out of the field, and put the other side in far enough to reverse the cur-

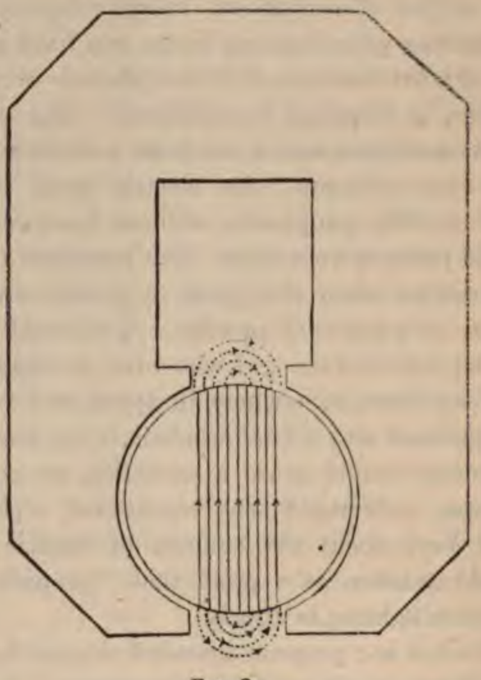

Fig. 8.

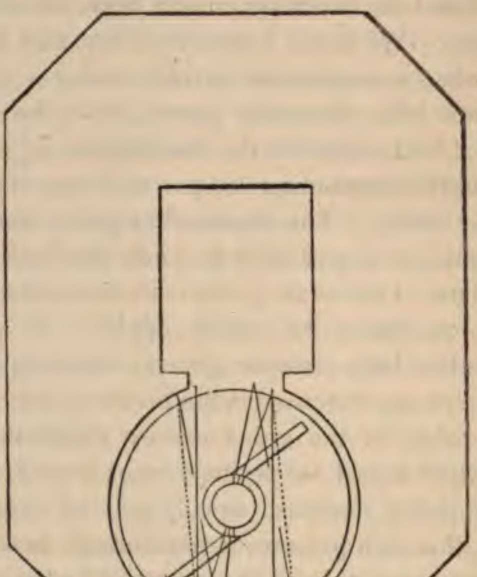

Fig. 9.

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* Paper read before the Institution of Electrical Engineers.

rent. If the brushes are not shifted, the conductors in the belt between the pole-pieces have current in alternate directions, so that they do not act as the coils of an electromagnet: the cross induction just under the pole corners is, however, the same. As the lead of the brushes is very small, the back current-turns are small also. As the change of field is rapid, it is necessary to use very narrow brushes at light loads, while there is sparking if there is the least inaccuracy. This winding is not perfectly suitable for very large machines with single magnets, for one conductor has its current reversed by the top leading pole corner, and the other by the lower one, and, as already explained, the top is generally stronger, so that more lead is needed on the bottom brush, and this is troublesome. In small machines this does not take place to the same extent.

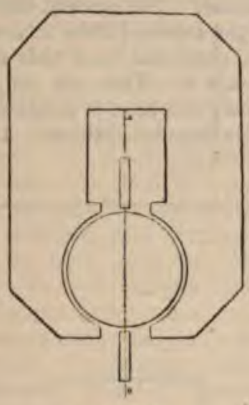

FIG. 10.

In some types of machines made in the United States a series coil is wound round the armature instead of on the field-magnets. It is then sometimes wound obliquely so that it lies against the two trailing pole corners. The idea in arranging it obliquely is, no doubt, to counterbalance the obliquity due to the armature current in some way. If the series coil is wound on the armature it must have enough ampere-turns to counterbalance the back current-turns on the armature, and in addition to this, enough to increase the armature induction enough to allow for the armature resistance at full load. In a large machine, therefore, it is equal to but little more than the back current-turns. As it is arranged obliquely it also counteracts part of the cross current-turns; but as the cross current-turns are always much more numerous than the back current-turns, the series coil in this position lessens the cross induction to a very small extent. This arrangement has therefore little advantage.

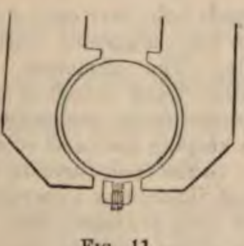

FIG. 11.

As a very weak field is enough to reverse the current in a section, a small pole-piece might be so applied to the armature as to reverse the sections at any convenient place. If the reversal could take place in such a position that the brushes would have a negative lead, the back current-turns would be converted into forward current-turns, and a machine could be designed to give constant E.M.F., or even a higher E.M.F. at full load, without any series winding on the magnets at all. Reversing pole-pieces, as they are called, were brought out some two years ago. Fig. 10 shows a simple case. Two reversing pole-pieces are shown. In order that there may be some induction in the same direction as that in the left limb of the magnet, it is clear that the line integral of the magnetic force from A to B must be positive. If the brushes are under these reversing pole-pieces, the line A B passes through the neutral points and the cross potential is $\pi n C/10$. Each reversing magnet must therefore have $\frac{1}{8} n C$ ampere-turns on it to counteract the cross current-turns, and a few more to cause the reversal. In large machines these pole-pieces are thus difficult to work in.

In a drum armature it would not be necessary to have two reversing poles; one wound with a little more than $\frac{1}{8} n C$ ampere-turns would be enough. Of course, these poles should have their coils in series with the armature, so that their excitation varies with the cross current-turns.

If the reversing pole-piece A is made larger, and attached to the yoke, the same number of current-turns is necessary, as the yoke is at the same magnetic potential as the centre of the armature, if the magnet limbs have equal coils, and the left pole-piece is not highly magnetised. As the reversing pole needs no excitation at no load, the shunt must be wound on both limbs equally. But the series coils may all be wound on one limb so that the yoke is not at the same potential as the centre of the armature at full load. Suppose the series coil has $n C/16$ ampere-turns on each former, with no reversing pole-pieces, the whole may be put on one former, and the reversing pole-piece then requires but little wire on it. But the reversing pole-piece does away with the need of much series winding on the fields, so there would not be anything like these series current-turns to be arranged at pleasure; in fact, if the reversing pole-piece were put on one side, so as to give negative lead to the brushes, there would be no need of any; and for this reason the reversing pole-piece is, in large machines at least, somewhat impracticable.

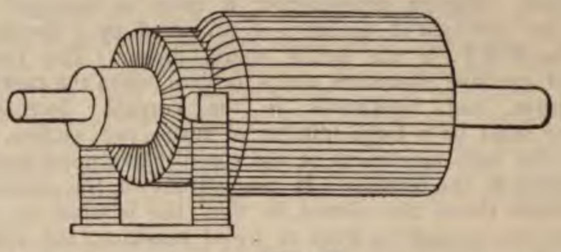

FIG. 12.

Fig. 11 shows an arrangement in which a small horseshoe electromagnet is arranged against the uncovered part of an armature. The horseshoe, as a whole, provides a convenient path for the line of induction due to the cross ampere-turns. If the electromagnet has more ampere-turns on it than there are on the part of the armature covered by it, one pole of it will act as a reversing pole-piece. This electromagnet is a little difficult to attach to the dynamo so as not to cause excessive magnetic leakage, as the sides of it come near the main poles of the dynamo.

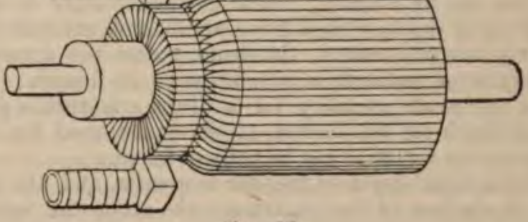

FIG. 13.

Fig. 12 is a diagram of another method. The armature proper is made as usual, but the connections to the commutator pass over the outside of a sort of subsidiary armature core. The E.M.F. needed for reversing a section is induced in the connection by a subsidiary field-magnet with narrow pole-pieces, as shown. The little field-magnets are wound in series with the main circuit. The connections are shown embedded in the core as in the notches of a Pacinotti armature. A small yoke is shown in Fig. 12; in practice the subsidiary magnets would be mounted on the bed-plate.

Fig. 13 shows an arrangement in which the subsidiary magnets are mounted on the rocker that holds the brushes, so that the machine can be regulated by moving the brushes backwards or forwards without producing sparking.

It is probable that some form of reversing pole-piece will come into general use, so these forms are described at length.

The advantages to be gained by such an arrangement are very great. The brushes do not need to be shifted as the load varies, which saves attendance and wear. Back current-turns are avoided, and this reduces the expense in the series field windings, and saves power now wasted in them. The field-magnets can be made smaller, and the induction in them will be the same at full load as at no load, so that the E.M.F. will not be unstable at light loads—a state of things which is not always avoidable at present.

A smooth-surface commutator, such as is generally used in low-tension dynamos, is seldom used on machines for arc lighting. No doubt the reason is this: An arc light machine must be series-wound, because it would be too expensive to wind the field-magnets with small enough wire to act as a shunt. Though series-wound, it must be arranged so that any increase of current is accompanied by a decrease in the E.M.F., or the lamps would flicker. The point of no sparking, therefore, shifts forward when the current increases, and backwards if the current decreases. There must be a large number of turns per section, so that the least movement of the non-sparking point causes sparking at the brushes. If the current of the machine increases above the normal, so that the brushes are no longer far enough forward to avoid sparking, the spark caused remains as a small arc till the current in the conductors of the section comes to the normal, and then disappears. If the machine current falls below the normal, the current in the section will have increased beyond the armature current, and the arc so formed may continue long enough to burn the commutator sections, or even to flash round. In machines with very few commutator sections the brushes are always given too little lead, otherwise there would be a flash round every time the current fell below the normal. No doubt this is why the practice in arc light machines is to use few commutator sections, to leave a small air space between them, and to give the brushes less than sparkless lead, so that the sparks then form between the end of the brush and the edge of the section, and do not destroy the surface of the commutator, and do not flash round. In spite of this, however, arc light machines have been made for some time with continuous-surface commutators.

GRAMME AND DRUM ARMATURES.

The drum armature was invented by Worms de Romilly, and in 1872 an account was published in *Les Mondes*.

First, as to winding. If a given armature is wound Gramme or drum, with a given number of external turns, there is less resistance in the drum, unless the armature is of very large diameter in proportion to its length. If the discs are made specially for a drum armature, a greater radial depth can be allowed, as the space used for inside turns in the Gramme can be utilised for iron.

If the radial depth of the disc is greater, and the induction in the iron of the armature is the same, the induction in the air gap is greater. This takes heavier field-magnets and more excitation, but increases the output of the armature. In addition to this it admits of more armature current-turns, as the cross induction can be increased also without reversing the induction under the leading pole corners. With a drum armature a very much larger single-magnet machine can therefore be built than with a Gramme.

Each section of the Gramme machine has a higher resistance than that of a drum with the same number of commutator sections. If a given armature is wound Gramme instead of drum, the self-induction is about double for each external turn, because the conductor also makes a little field of its own inside the armature, as in Fig. 3, being close to the iron, and the self-induction due to that would be about equal to that of the active part of the conductor. Two turns per section make the self-induction from three to four times as great as it would be with one turn. There is no mutual induction between the conductors in connection with the opposite brushes, as in a drum machine, so the self-induction in the Gramme may be taken as twice that of the drum. The Gramme may, however, be made with twice as many commutator sections, giving one turn per section. The self-induction of a section is thus greater than the self and mutual induction of half a convolution in the drum, and the resistance is also greater. The Gramme, therefore, still requires a stronger reversing field. The effect of this is that a small displacement of the brushes—or, what is the same thing, a small variation of the load—causes a greater spark at the tip of the brush. If the armature is perfectly symmetrically made, a position of no sparking can be found for any given load with a large number of turns per section, but the least variation of load or movement of the brushes will then give rise to sparking.

The Gramme has still another great disadvantage when used in large machines. The current-turns on the armature bring the sides of the internal hole to a considerable difference of magnetic potential, and this causes induction in the spindle, and heats it. This not only causes waste of power, but frequently the heat is conducted to the bearings and initiates hot bearings in addition. In a drum armature the sides of the inside hole have only a difference of potential of $l_a B/\mu_a$, as the armature current-turns do not affect the spindle. The armature can generally be made of such radial depth that it is slightly magnetised, while a Gramme armature is generally taken up as high as consistent with keeping cool and economy of field wire. The induction due to the back turns in the central hole in a Gramme machine introduces a correction in the size of magnet iron, as it acts as waste field. The induction in the hole is really oblique, and is due to the whole of the armature current-turns, so that the leakage is often very serious.

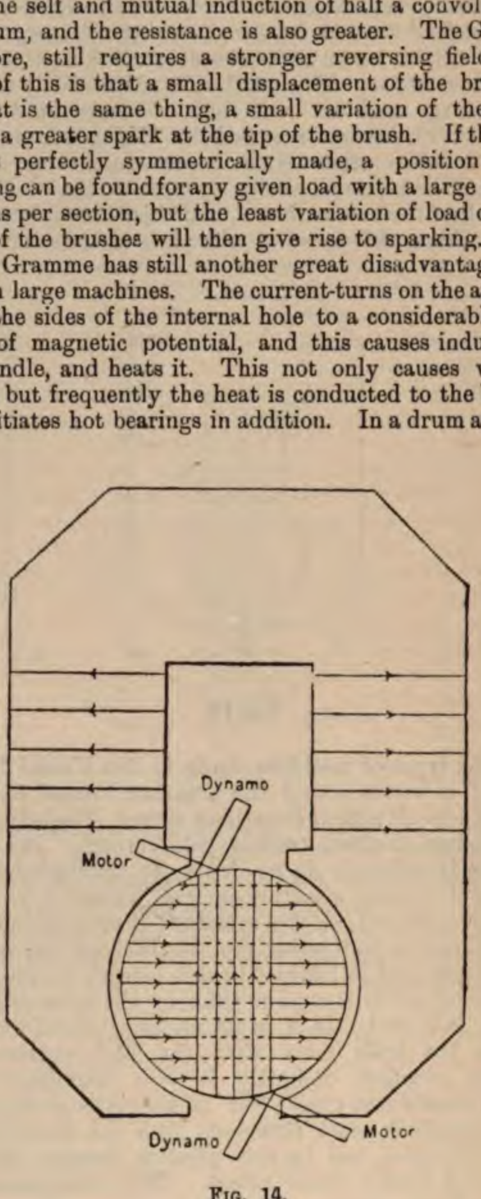

FIG. 14.

The drawbacks to the drum armature are all mechanical. In small drums, the difficulty of winding, the want of ventilation at the ends, and the difficulty and expense of repair, more than balance the advantages of small resistance and little wire, or large output.

In large machines the same drawbacks appear, but they are of less relative importance. Without doubt the large dynamo of the future will be a four pole or six-pole drum. By using four poles a much larger machine can be made without trouble from cross induction. The end connections, which are the greatest difficulty, then become much simpler, and any part of any convolution can be taken out for repair without disturbing the rest of the conductors. The central ventilation hole is much larger, as the radial depth need only be half what it is in a twofold machine.

RELATION OF MOTORS TO DYNAMOS.

Having discussed the full theory of dynamos, its application to motors is, of course, exceedingly simple. A motor is nothing but a dynamo running the other way, as a dynamo is a practically reversible machine.

Fig. 14 shows a dynamo armature with the position of the brushes, and the back and cross armature windings. For simplicity the brushes are shown as touching the outside of the armature instead of the commutator.

Suppose the direction of the currents in the field and armature to remain the same, but the direction of rotation of the armature to reverse, the dynamo then becomes a motor. The brushes must be inclined the other way, as shown dotted, otherwise the ends would catch in the commutator. The cross and back turns remain as before, so that the armature current opposes the field excitation. The brushes would be in exactly the same place in the motor as in the dynamo if the field where the commutation takes place were uniform. As a matter of fact, it is stronger near the pole corner, so a motor has a very little less lead. It has sometimes been said that the armature current assists the field in a motor, but this can only take place if the brushes are given a negative lead. The same result is obtained in a dynamo by putting the brushes back; but in both cases, of course, this leads to excessive sparking. It is sometimes imagined that some effect of the convolutions being commutated acts differently in a motor, but a glance at the diagram shows that the action is completely reversed. The section being commutated in a dynamo, opposes the movement of the armature; in a motor it assists the armature. No appreciable Foucault currents can be caused by the reversal of the section. If any were, they would assist the dynamo and oppose the motor, so that they would also be reversible.

Most writers on dynamos speak of loss of E.M.F. and loss of power by "self-induction of the armature." This is often supposed to amount to about 5 per cent. or 10 per cent. There must be some misunderstanding about this, as there is no way in which such a loss could take place. The current in the armature is sensibly constant except in the section being commutated. In any case power cannot be lost by self-induction.

There is, then, no point in which the dynamo is not perfectly reversible, except a merely theoretical difference in the position of the brushes, and there is no foundation for the idea that a motor should have a large armature and a weak field. In so far as any motor departs from the design of a good dynamo it is bad.

Of course the winding of the field-magnets in a motor is different.

(To be concluded.)

OPERATION OF ELECTRIC MOTORS WITH HIGH-TENSION CURRENTS.*

BY ELMER A. SPERRY.

The recent advance in the transmission of power by electricity in this country and abroad, and its adoption on a more or less extensive scale for the utilisation of distant water powers in the mining districts, indicate that the state of the art has reached that point where it has ceased to be an experiment, and where the most direct methods and the betterment of the various details of construction are matters of paramount importance. The present widespread interest in high-tension currents, and the discussion in connection with their use in the distribution of electricity for electric lighting lead me to the few remarks which follow, hoping to direct attention to their employment in the transmission of power, that this field for the use of high-tension currents may not be neglected, and may also receive whatever benefit may result from the general discussion now in progress.

For the transmission of power from one point to another there can be no question as to the utility and great advantage of employing high potentials. I speak now of the transfer of power from one point to another as contra-distinguished from the distribution of power for domestic or like purposes on a widespread scale. I, however, see no reason why in the near future this latter system also should not be prosecuted along the lines of high-tension currents, inasmuch as the phenomenal progress which has characterised electrical engineering enterprises in the past will bring the question of insulation to a point where danger to life and property will almost entirely cease to be an element to be considered. This will doubtless be brought about, too, by the utilisation of safety devices in the central plant, as well as throughout the construction.

In the consideration of high potentials as applied to the transmission of power, I propose to take a practical instance and carry it out along the line of each of the two foremost plans known to electrical engineers—namely, first by constant current, and second by constant potential—hoping by this means to point out the principal differences and ascertain, if possible, which is the better, cheaper, and more desirable method.

Before starting with the examples it is desirable to settle the fact that the work of each of the plants shall be satisfactory in so far as practical operation is concerned.

This will depend upon economy and regulation. We will assume, so far as the practical operation is concerned, that with shunt, compounded, or over-compounded generators, and with shunt or compound-wound motors, the matter of regulation may be satisfactorily worked out. But can the regulation be equally well maintained upon the constant-current plan?

It will be granted by all who have investigated the matter that constant-current generators can be regulated automatically, as to their potential, from zero to full load, in response to demands thereon for work, and this is done in a satisfactory manner.

But referring to the motor, the argument urged against the constant-current method is that the field-coils each have to be divided into a great many parts, each of these parts led to sections of a stationary commutator, and contacts driven backward and forward over this commutator by means of the centrifugal force of the varying speed-tendencies of the motor. That the potential difference of a constant-current motor may be made to meet the varying demands thereon for work, has been demonstrated. But it has been further demonstrated that the method of simply rotating the brushes about the commutator, between the points of zero and maximum potential difference, in a constant-current motor, may be satisfactorily employed to regulate the electrical energy absorbed.

The problem here is to obtain a sparkless commutator. This has received its solution and the mathematics of the various functions is known, and holds equally in motors or generators of any size. Furthermore, the sparkless region for varying currents has been broadened out until it is made to comprehend a variation of 50 per cent. of the normal current either side of the normal current point. By this is meant: Suppose the normal current to be 40 amperes, then there is a region of 20 amperes lying half each side of the 40-ampere mark through which range the commutator is entirely sparkless. This seems to me to be by far the simplest way by which to adjust a constant-current motor. Various devices may be employed to accomplish the mechanical rotation of the brushes in response to varying speed-tendencies; but that which will recommend itself as being the best is the one in which the varying centrifugal forces are called upon to do the least amount of mechanical work. These forces are not great until the speed differences are great, hence, for close regulation, they should be called upon to perform only functions involving light duty—for instance, calling into action mechanical forces which in and of themselves perform the ultimate duty of rocking the brushes, especially in heavy machinery where these elements are more or less large and ponderous.

The question may be asked, Can centrifugal force ever be employed to hold the motor within the same speed limits as shunt or compound winding? I answer, it can. There is no reason why the same degree of perfection should not be attained in this as in steam engineering. There are steam-engine builders who will contract to hold he speed within 1½ per cent. from full load to zero. No better result than this need be desired in any motor.

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* Read before the Chicago Electric Club, February 3, 1890.

Electrical science has advanced so rapidly and the theories have changed so radically, that statements put forward but comparatively a few years ago naming impossibilities in the art have been often exhumed in the present day as marks of advancement. Writers on dynamo machinery are so modern that, profiting by the errors made by former writers upon other subjects, they have been rather wary in pointing out impossibilities. But sweeping assertions must be made, and writers who are considered as high authorities have pointed out the impossibility of making a sparkless commutator under the conditions named above. Since it now has become an accomplished fact, it may be said that doubtless these statements denying the possibility of results of great importance are useful as incentives to those working along the line who do not agree with the author.

There is, however, one point with regard to a sparkless commutator under conditions of constant current which I wish to point out—namely: That from the maximum to the minimum point of potential the brush must always be handled in the direction it points from the former point toward the latter, and not in the opposite direction. The distribution of potentials about a commutator is shown in Fig. 1.

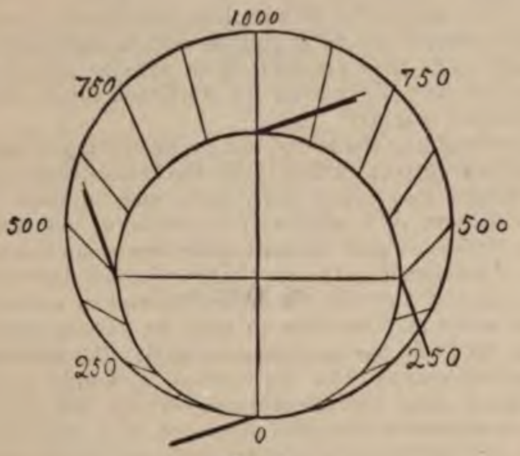


Fig. 1.

From this figure it will be seen that the distribution is equal on either side of the maximum line, and there seems on the face no reason why the brushes should not reduce the potential if rotated in either direction from the maximum point. Either toward the left or toward the right the minimum point or position B, or B′. While the brushes in their movement to the left are perfectly non-sparking, if attempt is made to move them in the opposite direction to position B′ they spark seriously. No reason for this has been put forth to my knowledge. The following is offered as a possible explanation of this phenomenon. Allow Fig. 2 to represent either a dynamo or motor with commutator at centre and armature cord disposed between N N, the north pole-pieces, and S S, the south pole-pieces; *t t t* and *f f f* show the windings, *n* indicates the polar axis of the armature. When this armature is used as a generator it will rotate in the direction of arrow G, and when used as a motor it will rotate in the direction of arrow M. The small arrows under the pole-pieces indicate the direction of the lines of force to or from the armature core. Suppose the system to be operated as a generator, and the brushes to be rotated over toward the right. The polar line, *n* or the pole in the armature, will be held by the overmastering magnetism of the pole-pieces to a position which constantly tends to be back of or toward the left of the brush contact, thus leaving the brushes among the coils, *f f f*. The current in these coils is in the direction going from the observer, and hence is antagonistic, if the expression be permissible, to the direction of the lines of force emanating from the poles N N, therefore there is no tendency to the development of abnormal E.M.F.'s between the adjacent coils. However, if the brushes be rotated to the left the displacement or the drawing of the polar line, *n*, by the south pole, and its being repelled by the N N, will still keep it to the left of the commutator brush contact. As soon as the windings, *f f f*, come within the range of the pole-pieces S, their current direction is in harmony with the direction of the lines of force into the pole-pieces S S, thus giving an exaggerated value to the potential developed in adjacent coils. These coils, being directly under the contact of the brush, develop local currents acting through the brushes producing the tremendous sparking observed.

When the system is used as a motor and is revolved in the direction of the brushes and arrow, M, the converse of this law operates, inasmuch as the polar displacement is reversed which would require, as is found in practice, that the brushes, M, should be rotated to the left for non-sparking instead of to the right as in the case of the generator.

To proceed with the example. Let us take a transmission of 50 h.p. three miles distant upon a circuit of 31,680ft. Place the total economy of transmission at the low figure of 66 per cent., which will be distributed 14 per cent. each in dynamo and motor, and 5 per cent. in the line. We will adopt as potential 3,000 volts; transmissions are used 24 hours a day with this voltage as well as scores of arc light dynamos with no practical inconvenience. This voltage would give about 18·7 amperes in the constant-current distribution. Let us assume that a constant potential may be worked upon the same voltage. Now let us examine the two plants. The line wires are the same size, with this difference, however, that in the constant current they are only subjected to 3,000 volts at such times as the plant is working at its maximum; during all other times the voltage is below, thus subjecting the insulation to a far less strain with less liability of breaking it down, whereas, in the constant-potential system this 3,000 volts is maintained constantly whether there is any power being used from the motor or not, even if the motor is driving itself solely. The heavy stress upon the insulation, therefore, is constant.

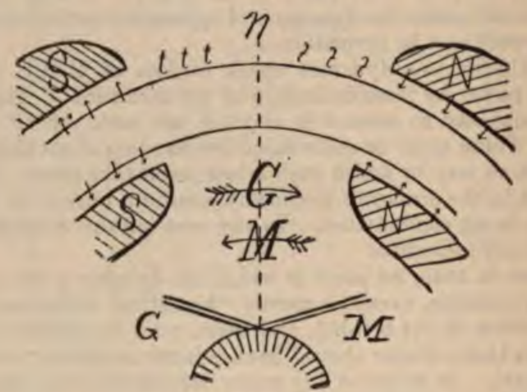


Fig. 2.

The armatures are practically the same, because for the same speed and same field intensities the number of convolutions and sizes of wire will be equal.

Let us examine the fields. Taking 3 per cent. of the total energy required in the fields, we have in the field of the constant-current machines merely a series wire measuring 10,000ft. with a difference of potential at its ends of 100 volts, running 100ft. to the volt, being a large wire easily handled and one that will withstand shocks, jars, and rough handling indefinitely. Taking the same number of square mils per ampere for the wire in the field of the constant-potential machines, we find that an extremely small wire has to be employed. We find that this wire must be 62 miles in length. We find that the difference of potential between each successive layer upon the fields is 200 times that which exists in the constant-current fields, taking at least forty times as long to wind the same. This great increase of potential difference between the successive layers should require double covered wire.

Let us see what bearing this has upon the case. With double covered wire of this size the ratio of insulation to copper would be 44 per cent., whereas in the constant current the ratio of insulation to copper is only about 3 per cent. This requires about 40 per cent. more field space in case of the constant potential, which means a larger machine as compared with the constant-current generator. The actual net cost, pound for pound, of wires in this instance would $3\frac{1}{3}$ times as great in the constant potential as in the constant-current machine, making the total cost of insulating wire for the field of the constant-potential machine over four times that of the constant-current machine.

These details indicate plainly impracticability on the part of the constant potential and perfect practicability in the case of the constant current. This impracticability is not decreased as the complexity of the machine is increased by being compounded or over-compounded. In fact, an eminent writer on constant-potential machinery, no earlier than November last, in discussing a pressure of only 1,000 volts, states "that where high-pressure generators are used, it is very expensive to wind a shunt field of high enough resistance to stand the E.M.F.'s of the armature. It is much cheaper to wind a shunt field for low pressure, say, of 110 volts, and separately excite it by a small constant-potential dynamo." This, of course, would add to the plant another item of expense which would be slightly more expensive, though far more practicable, than the field-winding described above on the 3,000-volt basis.

In the practical operation of constant-potential motors, the use of an artificial resistance is imperative, by means of which the lack of counter E.M.F. in the armature of the motor as the speed starts and increases to the normal is made up by dead resistance. This resistance for large motors occupies much space and in case of high potentials is expensive. In the constant-current plant, however, a switch shunting the motor is opened and there is at once thrown upon the motor only its normal amount of current, and as the same starts and its counter E.M.F. increases, the E.M.F. of the generator also increases in proportion, until its normal speed is reached, without at any time any increase of current whatsoever or tendency to burn. On the other hand, with the constant potential should an accident happen and the machinery be brought to a stand suddenly, there is serious danger of overheating and burning the coils of the armature and series coils of the fields. In this emergency the constant current is cared for automatically by the regulator on the generator which diminishes the potential upon the line, correcting the current intensities almost instantaneously. Upon both constant-potential motor and generator as the load increases and diminishes a manual adjustment is also required to keep the brushes on the non-sparking point.

It is found in practice that if constant-potential motors, as ordinarily constructed and connected in circuit, are belted to the same shaft or otherwise connected to the same work so that they must revolve together, the result obtained is unsatisfactory because of the fact that the load will be unequal and disproportionally divided. This is due to the fact that it is impossible to construct two electric motors, the armatures of which shall have precisely the same counter E.M.F.'s, therefore, if two motors coupled together in this way are supplied from the same main, the armature which produces the lowest counter E.M.F. will take a larger current than the other motor. The effect of this increased flow is to greatly exaggerate and enhance the difference existing between the motors, because the fields of the motors are disturbed by the increased flow, and its counter E.M.F. is still further reduced, resulting ultimately in burning or destroying one of the motors.

Prof. Rice has recently devised a system to overcome this effect, but at best it is complicated, and still further increases the complexity of the machine. Another way would be to run each motor connected to a separate generator with separate line wires, but this, to say the least, is expensive. Any number of constant-current motors may be attached to the same power; in this case their regulators are dissimultaneously operating. Having thus pointed out some of the differences, let us look into the stations provided with these two sets of apparatus. In the constant-potential generating station we find a very large machine. Upon the wall are an ammeter, a voltmeter, a large rheostat for controlling the fields, and most probably an exciter and duplicate set of station instruments. Connected with the exciter, at the motor end of this line, we find the motor, a large rheostat and probably another exciter. Going over now to the generating station of the constant-current machine, we find an automatic generator which is smaller than the constant-potential machine. On the wall we simply find an ammeter. At the motor station we find a motor supplied with a small and durable mechanical regulator for its fields or preferably for its brushes, and perhaps an ammeter upon the wall. This constitutes the entire plant; nothing about it but what can be easily comprehended and successfully operated by an engineer of ordinary intelligence, and we observe an entire absence of complexity of connections in the machines, or circuits running back and forth from the machine to the various devices upon the switchboard or wall, and the first cost and cost of installation of these various devices is decidedly in favour of the constant-current system.

It may be said that some of the objections above will be eliminated by reducing the E.M.F. of the constant-potential plant. Let us reduce it one-half, that is, to 1,500 volts. Now, it is true that the fields are less difficult to wind, the length of the wire is less, and the wire somewhat larger, enough so, perhaps, to do away with the necessity of an exciter. An increase, however, will have to be made in the size of wire on the exterior circuit. The current is now increased to $37\frac{1}{2}$ amperes, and for the same loss in the exterior circuit the wire will have to weigh 14,000lb. instead of 4,000, costing 2,800dols. in place of 800dols., and if the potential is still further reduced to 1,000 volts, in which case there would be $56\frac{1}{4}$ amperes, the wire would weigh 18 tons and cost 7,200dols., as compared with 800dols., for the constant-current plant, with poles in the former, at much less intervals and heavier construction all through.

It is hoped that free discussion will be had upon these points, and that additional facts may be developed which will aid in arriving at the most direct method of distributing power electrically.

FIRE DANGERS.

The following letter has been addressed to the *Times*:

Sir,—At a recent meeting of the Electrical Section of the London Chamber of Commerce, Mr. Crompton, the Earl of Crawford, and I were asked to address you with reference to the fire that recently took place at No. 8, Grosvenor-square, in which house the electric light was used, and also with reference to the danger which it is alleged is connected with the use of the electric light.

Lord Crawford's illness, and Mr. Crompton's and my absence from London on business have prevented our writing a joint letter. I am therefore alone responsible for the opinions which I express.

It is patent to the whole world that no system of artificial illumination can be free from danger. Many accidents have happened from the use of candles, of oil lamps, and of gas, and a vast amount of property has been destroyed, by gas flames and gas explosions, in the present century during which gas has been established throughout the civilised world.

The clear and lucid reports which Captain Shaw puts forth annually give the number of fires in the metropolitan district alone.

From these reports it appears that the number of fires within the metropolitan area which have been caused by candles, by gas, and by lamps is as follows:

	1887.	1888.	1889.	Total.
Candles	142	113	136	391
Gas	188	197	209	594
Lamps	245	205	257	707
Electric light	—	1	2	3

It is hardly necessary to say that the number of electric lamps in use is but a small percentage of the number of the other lights. Nevertheless the fact remains that we have now in the metropolitan area an annual average of 565 fires which owe their origin to lamps, to gas, or to candles, and have as yet had only four fires from the use of electric light. The number of fires caused by gas and lamps throughout the world is really appalling.

From the official report on No. 8, Grosvenor-square, made by Mr. Musgrave Heaphy, who has had more experience in the inspection of electrically-lighted houses than anyone else in the kingdom, it appears that the work in the house of No. 8, Grosvenor-square "was not in accordance with any fire insurance rules," and from the description which Mr. Heaphy has given, as the result of his inspection, it is manifest that the fire in question was not due to the use of electric light, but to the unworkmanlike, imperfect, and uninstructed manner in which the wiring of the house had been carried out.

Under the Electric Lighting Act, 1888, the Board of Trade is obliged to lay down very stringent regulations as to the mode in which electricity is to be conducted from the central station to the entrance of the houses, but the Board of Trade control, and that of the local authority also, ends at the boundary of the Englishman's castle, into which neither Government nor local officials penetrate. In fact, all control ends at the house itself, unless an insurance office or the company supplying the electricity insist upon further inspection.

Some of the fire insurance companies have organised a staff of inspectors, and the offices may be trusted to protect their own interests, but in the case of uninsured houses there is no control whatever, and the only power of inspection is that the supply company may refuse to turn on the current until they are satisfied that the work inside the house has been carried out in a workmanlike manner.

Of course, this will all be rectified in time, and before long the occupiers of houses will discover that it is necessary in their own interests, to say nothing of safety, that they should not give out this work to a bellhanger or upholsterer, but should employ some electrical firm of standing to carry out the work inside the house, and will, if they are wise, insist, before they pay the bill, that the certificate of a duly authorised and competent electrical engineer or fire insurance expert should be produced certifying that the wiring, etc., has been properly done and with all due regard to safety.

I believe that there is an absolute consensus of opinion amongst all those competent to judge that electric light on a low-tension system, at any rate, may be brought into houses in which the whole of the internal arrangements have been carried out in accordance with the rules of the best insurance companies with greater safety than can be obtained with any other artificial means of lighting.

I say low-tension system advisedly, for when we speak of high tension we enter the region of controversy, and some of the opponents of high tension are perhaps inclined to exaggerate the danger from its use.

I have no experience of the use of high-tension currents. This system, however, is in the hands of men of experience and ability, and as they are fully alive to the fact that their commercial success will depend upon the excellence of the workmanship, in the care exercised in carrying out their operations, and in their freedom from abnormal fire risks, they may, I think, be trusted to do everything that is necessary to reduce the danger to a minimum. They are confident that they can transform high-tension currents in such a manner as to render them as safe as low-tension currents, and I think it will be time enough to pronounce judgment when they have carried on their system on a large scale and for some considerable time.

It seems clear that the battle between high tension and low tension will be fought just as the battle between the broad gauge and the narrow gauge has been fought out by the railways, and we shall eventually, perhaps, have only one system in general use. As in the case of railways and in many other things, we may expect the survival of the fittest. I shall not venture to express an opinion as to which system will eventually survive.

It is certainly wrong to say that "no danger is to be apprehended from those who use the low-tension system," because it is notorious that such an installation as is described by Mr. Musgrave Heaphy in Grosvenor-square would have been no more free from risk with a low than with a high tension system.

In short, I have no hesitation in saying that a house properly wired and with all details carried out in a workmanlike manner on the high-tension system is more free from danger from fire than a house improperly wired and with the details carried out by uninstructed workmen on the low-tension system; while I firmly believe that any house in which due attention is paid to all internal electrical details, whether supplied with current on the high or low system, is infinitely freer from chance of fire than if candles, gas, or oil are used to light the house.

But I must touch upon the reports which have been received of the serious accidents in New York. It is very difficult to deal with these in an exhaustive manner, as we have not sufficient data to enable us to arrive at a conclusive judgment in the manner.

So far as I know, nearly all the accidents which have been reported from America have occurred in New York city or State. Some of those narratives are most sensational, not to say ridiculous. I have no wish to deny or minimise the accidents that have occurred in consequence of the use of high-tension current in the streets of New York. It must, however, be remembered that there is little public control in such matters in New York city, and that there is no chance of companies being allowed to do as they like in connection with the supply of electricity in this country as they have apparently been permitted on the other side of the Atlantic.

I must confess that it seems a little hard, because the New York gas companies have allowed gas to leak from their mains to such an extent that the whole earth around them has become impregnated with gas, that the accident which recently occurred, owing to the passage of an electric conductor through the gas-impregnated ground, should be ascribed to electricity. Surely experts would classify it under gas.

As a matter of fact, if the gas companies in New York go on passing some 10 per cent. of the gas from their mains into the earth for a few more years, it is extremely probable that the end will be an explosion infinitely more serious in its extent and considerably more disastrous than that which recently took place.

Everybody in London is interested in this question, for on the authority of "Haydn's Dictionary of Dates," it seems that in 1860 the escape of gas from the mains in London was 9 per cent. Perhaps this leakage has been reduced since 1860; but if 9 per cent. of the gas which passes through the mains in London leaks into the surrounding earth, can engineers and experts assure us that there is no danger therefrom?

I do not know the number of fatal accidents that have happened in New York; the number has been, at any rate, deplorable and sufficient to excite alarm. I would, however, call your attention to the fact that electricity is used to an enormous extent all over the United States, high-tension as well as low-tension currents being in many places as common as gas, and with the exception of the supposed, but not proved, connection of the big fire in Boston with electric lighting, I am not aware that fatal accidents or fire accidents have occurred from the use of electric lighting in the United States generally; they seem to be confined to New York State and city.

Mr. Addenbrooke, in a paper recently read before the Institution of Electrical Engineers, states that there are more than a quarter of a million of arc lamps in the United States. If, then, the accidents which arise from electricity are found to be mainly grouped in one small portion of the United States, surely it must carry conviction to all reasonable minds that the fault in that particular locality is due to some defect in the mode in which the work is carried out, and not due to any inherent danger in electric lighting itself. The number of incandescent lamps in use in the United States is, I have reason to believe, nearer three than two millions, which are fairly scattered all over the vast American continent, yet we do not hear of accidents connected with their use.

In Berlin, Rome, Milan, Vienna, Paris, London, and all over Europe, in Australia, South America, and all over the world there must be half a million of arc lamps and several millions of incandescent lamps in regular nightly use, yet we seldom hear of accidents in connection with this great development of electric light. The percentage of accidents therefrom is extremely small.

In conclusion, I think that the public may rest assured that while the employment of electric lighting does not altogether get rid of the liability to accidents which is inherent in everything human, and which at present reaches a most serious percentage in the case of all ordinary artificial illuminants, yet it tends to reduce the risk to a minimum, far below the chances of fire from candles, oil, and gas.

The extent of the security is, however, in exact proportion to the skill and care exercised by those who wire the house, while cheap work is in nearly every department of life poor and bad, in wiring for electric light it is simply fatal. I am confident that when a competent electrical firm is employed and a fair price paid for the wiring, etc., of a house; when a consulting electrical engineer or a competent fire insurance expert is called in to report upon the work before it is paid for, that those who introduce electric light into their houses may enjoy amongst other advantages a sense of security from fire not to be attained by any other means of lighting their houses. I venture to suggest that every householder whose house has been wired by anyone not an electrical engineer should call upon the office in which his house is insured, or if uninsured upon an electrical engineer, to inspect and report upon the electrical apparatus which has been fixed in his house; and to those who are at present thinking of having their houses wired, I would suggest that they should entrust the work to some electrical firm of known standing, of which there are several, but whom it would be invidious to name. To avoid misapprehension, I should like to say that, as neither of the companies with which I am connected undertake installations or the wiring of houses, I am quite impartial, and have no interest to serve, except to aid in the removal of any prejudice which the sensational narratives have created, and to assist in allaying alarm for which there is no foundation.

There will, of course, be the usual risks of fire in the central stations, where engines and boilers, etc., will be in constant use, as is shown by the recent fire in Pearl-street station, New York; but in the electrically-lighted houses in which the work is properly effected the chance of fire will be but small and the sense of security will be proportionately increased. We shall of necessity have fires and accidents from the use of electric light, but it is to me incredible that with houses properly wired and with a due proportion of proper cut-outs and with regular inspection the fires in such houses from the electric light will ever reach one-half of the present appalling average of fires in houses otherwise lighted.—I am, sir, your obedient servant,

S. FLOOD PAGE.

COMPANIES' MEETINGS.

CHELSEA ELECTRICITY SUPPLY COMPANY, LIMITED.

The annual general meeting of this Company was held on Wednesday at their central station, Draycott-place, Sloane-square.

Mr. J. Irving Courtenay, who presided in the absence of Lord Thurlow (the chairman), stated that their central station had been opened for the supply of electricity since the second week in April last, when current was first turned on from the 2,000-light storage battery sub-station at Clabon-mews. Since then the increasing demand for electric light had induced the Directors to open two other similar battery sub-stations in different districts, and the plant for a fourth was in course of erection. One of the advantages of the system adopted by the Company was that it lent itself readily to gradual increase of plant, according to the necessarily gradual increase in the demand, and did not necessitate at starting the large expenditure on buildings and heavy machinery as with direct running systems, in which a long time might elapse before sufficient work could be found to employ the plant fully. All the electricity which had been produced had been supplied to the consumer direct from the E.P.S. storage batteries. The consumer was never in any circumstances in connection with the charging current, and therefore he was not subject to the disagreeable pulsation and inequality in the light often noticeable when it was produced direct from running machinery. Nor was he in any way liable to the inconvenience of sudden total extinction of his light from difficulties or mishaps with boilers, engines, or dynamos. There were no symptoms of wear discoverable even on those E.P.S. batteries which had been longest in use, and in no case had a single plate been renewed. They had found in practice that the cost of producing a Board of Trade unit of electricity was—in October 4½d., in November 3⅝d., in December, 2 2-3d., and this should be further improved when their system of underground conductors was quite complete. After speaking of the success which had attended the working of the E.P.S. system at Chelsea, the Chairman stated that storage batteries could now be relied on, and could be guaranteed to give 70 per cent. on an average, in practical working on a commercial scale, of the amount of electricity put into the battery, and they ordinarily gave more. Those who were interested in rival systems argued that the great drawback to the storage system was the initial cost; but he maintained that the difference in favour of other systems (if any) would disappear if an adequate duplication of apparatus, plant, and buildings were provided. They were vigorously pushing their business in Chelsea and Kensington, and there was every reason to expect a large increase this year.

Mr. Nugent Daniell seconded the motion.

Major-General Webber, C.B. (a director), described the Company's system as essentially a network system. They were enabled to maintain what the Act of Parliament required—constant pressure over all the district in all hours within certain limits. In times of abnormal consumption, however, they might not be able to maintain the pressure at, say, the busiest hour of the day to the fullest extent of the standard required, owing to the supply in one place exceeding the estimate and in another not coming up to the estimate. This probably was the only point in which their system, in its infancy, might be said to be open to a small objection, though they had no serious difficulty in connection with it. When they came to examine their own and other systems they would find variations elsewhere in the pressure of even 10 or 15 per cent., whereas in their own case the variation was never more than 4 per cent. All the money which had been expended had been in actual work, and the money which they had still to lay out to fulfil their statutory obligations would also be expended on mains, etc., which would earn revenue directly.

The **Chairman**, in reply to Prof. Ayrton, stated that the cost he had mentioned in his opening remarks of producing a Board of Trade unit of electricity included all charges except general charges.

Major-General Webber said that the cost mentioned, though perfectly correct, might be a little increased in actual practice, but the result was exceedingly favourable. The central station had a capacity of supplying 75,000 lamps installed.

The motion was unanimously adopted, and resolutions were afterwards passed re-electing the retiring Directors and Auditors, and authorising the Directors to borrow on debentures a sum not exceeding £50,000.

The **Chairman** stated that they would issue at once only £12,000 or £15,000, but two years later they might require to issue another £15,000.

INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS COMPANY, LIMITED.

The twenty-sixth ordinary general meeting of this Company was held last Friday at the City Terminus Hotel.

Mr. S. W. Silver, who presided, stated that the year's working had resulted in a net profit of £57,748. With the balance brought forward, after deducting the interim dividend, they had a disposable balance of £62,036, from which they recommended a dividend of 10s. a share, making the distribution 10 per cent. for the year, and leaving £41,236 to be carried forward. The laying of the 800 miles of cable mentioned in the last report had been successfully completed. Their steamers had been only partially employed. Their general trade operations amounted to about the same as those of the previous year. Notwithstanding the adverse circumstances against which they had had to contend and which had prevented their participating in the improvement in the trade of the country, their general operations had kept up to the highest amount previously reached. As regarded the strike at Silver town, they had not far to seek for the exciting cause. The dock movement took place in the vicinity of their works and affected a number of the labourers there, who were instigated by the clamour of professional agitators and by several irresponsible advisers, who, he thought, would now admit that they had seen their mistake. The demand made upon the Company for an increase of pay, notwithstanding that the wages given by them were in excess of those prevailing in the locality, was refused. Considerable numbers of the employés had been inclined to pursue their work, but combined attacks were made upon them, and in effect a reign of terror was set up. He had no hesitation in asserting that this state of things might be traced to the inaction of the police, as in the latter stages, when the police adopted more active measures, the whole movement collapsed, and the employés returned quietly to their work on the same terms as before. They must attribute this, for the Company, happy conclusion to the firmness and sound judgment of Mr. Matthew Gray, the managing director, who had been ably supported by his sons, the whole staff of electricians, the clerks foremen, and a strong force of assistants, including several workmen and workwomen. From the outset Mr. Gray had had the entire confidence and support of the Directors, and he desired to add that throughout Mr. Gray's long and active life it had been his aim and object to see that the workpeople were justly and kindly treated. He concluded by moving the adoption of the report and the payment of the dividend recommended.

Mr. Neil Bannatyne seconded the motion.

Mr. Webber proposed an amendment increasing the dividend by a further 5 per cent. He stated that the distribution suggested by the Directors would only give him a return of 4 per cent. on the price he had paid for his shares, and that if his amendment were adopted over £20,000 would remain to be carried forward.

Mr. Codner seconded the amendment.

It was pointed out that the amendment could not be put, the

Solicitor (Mr. Hutchins) stating that the shareholders had no power over the dividend except to sanction that which was proposed by the Directors.

Mr. Webber stated that in that case the articles of association of the Company ought to be altered. The Board might hereafter come before the shareholders with a proposal to carry forward £100,000 and to pay no dividend.

The **Chairman** stated that it was most desirable for the Company to be in a position to buy the raw material they required judiciously in any quantity.

The original motion was then put and declared carried, with five dissentients, and a resolution was afterwards passed acknowledging the services rendered to the Company during the recent strike by Mr. Gray, the chief manager, the heads of the several departments at Silvertown, and others.

CITY OF LONDON AND SOUTHWARK SUBWAY.

The eleventh ordinary general meeting of this Company was held on Tuesday at Winchester House, Old Broad-street.

Mr. Charles Grey Mott, who presided, said that it was with mingled feelings of regret and satisfaction that he rose to move the adoption of the report and accounts—of regret because he had again to meet them with an unopened line, and of satisfaction for the reason that during the past half-year very great progress had been made with their undertaking. They had completed their boiler-houses at Stockwell, upon the erection of which the greatest care had been bestowed, with the result that there was practically no smoke arising from them. The engine-house was rapidly approaching completion, and they were now preparing to fix the engines and dynamos there. The arrangements for working the hydraulic lifts, the shafts for which were already finished, were being rapidly carried out. The experiments made during the past six months with an electric locomotive and carriages in the tunnel between King William-street and Great Dover-street had proved very satisfactory. They had power to issue a further sum of £50,000 of debentures, making £150,000 in all. Of that amount £30,000 still remained to be taken up. The Directors had thought it wiser to issue them as terminable debentures for five years at an extra rate rather than as permanent debenture stock. He believed that the railway would be open for traffic by July or August next.

Mr. Walter Robinson seconded the motion, which was unanimously adopted.

The retiring Directors and Auditors were afterwards re-elected.

At a subsequent special general meeting a Bill empowering the Company to extend their subway to Clapham and to change the name of the Company to the City and South of London Railway Company was unanimously approved.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The traffic receipts for the past week amounted to £4,662.

West India and Panama Telegraph Company.—The estimated receipts for the half-month ended February 15 were £3,581, against £3,348.

Western and Brazilian Telegraph Company.—The receipts for the past week, after deducting the fifth payable to the London Platino-Brazilian Company, were £3,549.

Electrical Engineering Corporation.—Letters of allotment to applicants for shares and debentures of the Electrical Engineering Corporation, Limited, have been posted to those subscribers to whom allotment was made at the last Board meeting.

Direct Spanish Telegraph Company, Limited.—The Directors of this Company recommend a dividend at the rate of 10 per cent. on the preference shares and one at the rate of 6 per cent., tax free, upon the ordinary shares, making 5½ per cent. on the ordinary shares for 1889 against 4½ per cent. in 1888, carrying forward £846.

PROVISIONAL PATENTS, 1890.

February 10.

2113. **Improvements in the manufacture of plates of electrodes as used in secondary batteries or accumulators.** Gustave Adolphe Schoth, 230, Euston-road, London.

2153. **Improvements in telephone-switch-boards.** Duncan Dewar, 4, South-street, Finsbury, London.

February 11.

2199. **Improvements in cores and armatures for electro-magnets and other purposes.** Stanley Charles Cuthbert Currie, 24, Southampton-buildings, London. (Complete specification.)

2212. **Improvements in fire-alarm systems (known as fire-alarm telegraphs).** Henry Frederick William Lewis, 8, Meridian-road, Redland, Bristol.

2215. **The cure of stammering and stuttering and for the cure of impediments in the speech—"The Electric Articulator."** Auguste Schaefer, 250, Cambridge-road, Hackney.

2219. **Improvements in telegraph printing apparatus.** Henry Oswald Rudolph, 28, Southampton-buildings, London.

2234. **Improvements in electro-mechanical movements, chiefly designed for regulating the carbons in electric arc lamps and for similar purposes.** Samuel Edward Nutting, 45, Southampton-buildings, London. (Complete specification.)

February 12.

2255. **Improved multiple automatic transmission for telephonic and telegraphic systems.** George Macaulay-Cruikshank, 62, St. Vincent-street, Glasgow. (Michael Schwabacher, Germany.) (Complete specification.)

2272. **Improvements in apparatus and devices for operating, compensating, regulating, measuring, and recording electric currents.** Arthur Cecil Cockburn and Francis Teague, 32, Gaisford-street, Kentish Town.

2273. **Improvements in voltaic cells or primary batteries.** George Richard Postlethwaite, 6, Livery-street, Birmingham.

2297. **Improvements in apparatus to be used for electrolytic purposes.** James Charles Richardson and Trevenen James Holland, 6, Bream's-buildings, Chancery-lane.

2302. **Improvements in electric batteries working with two liquids or electrolytes.** Henry Weymersch and Robert McKenzie, 47, Lincoln's-inn-fields, London.

February 13.

2337. **Improvements in electro-magnetic motors.** George Richard Postlethwaite, 6, Livery-street, Birmingham.

2347. **Improvements in primary batteries.** Sir Charles Stewart Forbes, Bart., 21, Finsbury-pavement.

February 14.

2404. **Improvements in electrical switches.** Frederick Bathurst, 111, King Henry's-road, South Hampstead.

2439. **Improvements in or connected with electrical accumulators or storage batteries.** Frederick Stephen Roberts, 115, Cannon-street, London.

February 15.

2464. **Improvements in electric light fittings.** Charles Mark Dorman and Reginald Arthur Smith, 24, Brasenose-street, Manchester. (Complete specification.)

2476. **Improvements in fusible cut-outs for electrical circuits.** Alfred Henry Walton, 20, Richmond-crescent, Barnsbury.

2491. **Improvements in casings, beadings, and mouldings, for containing, covering, and insulating electric wires for lighting or other purposes.** Walter Gritten and Arthur Parmley, 35, Southampton-buildings, London.

2496. **An improvement in electrical conductors.** John Baragwanath King and Thomas Edwin Bickle, 28, Southampton-buildings, London.

2503. **Improvements in electric arc lighting.** Llewellyn Saunderson, 24, Southampton-buildings, London.

2504. **Improvements in apparatus for propelling vehicles by electricity, and for protecting electric conductors.** Frank Wynne, 46, Lincoln's-inn-fields, London.

2606. **Improvements relating to electric batteries.** Edouard Charles Francois Verschave and Aimé Baron, 4, South-street, Finsbury, London.

SPECIFICATIONS PUBLISHED

1889.

3022. **Telephone mouth-piece.** Cotterell. 6d.

3365 **Electrical conductors.** Kamm. 8d.

4235. **Coin-freed dynamo-metric apparatus.** Conte. 8d.

4566. **Electrically lighting trains.** Preece and Sayers. 8d.

4998. **Magneto-electric machines.** Bowron. 8d.

5063. **Measuring electric currents, &c.** Hungerbuhler and Todman. 8d.

5563. **Electric batteries.** Lake (Lacombe and Co.). 8d.

5867. **Telephone circuit switches.** Graham. 8d.

9496. **Accumulating electric energy.** Marx. 8d.

14677. **Electro-magnetically separating metals, &c.** Moffatt. 8d.

18838. **Electric conductor conduits.** Pitt (Johnstone). 11d.

28235. **Electric accumulators.** Correns. 6d.

20717. **Electric contact mechanism.** Prentiss. 6d.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday.
Anglo-American Brush	—	2⅝
— Pref.	—	1⅞
India Rubber, Gutta Percha & Telegraph Co.	10	18⅞
House-to-House	4½	5
Metropolitan Electric Supply	—	4½
London Electric Supply	5	3½
Swan United	3½	5½
Telegraph Construction	12	45
— 6%, 1889	100	105
National Telephone	5	5¼

NOTES.

Cassel.—The authorities of Cassel have decided to open a municipal central station.

Private Bills.—In the House of Commons, the Aberdeen Electric Lighting Bill was read a second time.

Gas-Electrics.—The Saint-Sebastien gas company have commenced an installation for supply of electric light to this town.

Barcelona.—The Societa Catalona has arranged with the Municipality of Barcelona for the installation of a central electric lighting station.

Personal.—We understand that Mr. F. Bathurst is starting for the United States next week to visit American installations and introduce some of his useful novelties in electric fittings.

Medal Awarded.—Messrs. Shippey Bros. have been awarded the "Silver Medal Diploma" for their electric motors exhibited by them at the recent electrical exhibition at Birmingham.

Bell Patents.—The United States Government has obtained an extension of three months in which to introduce evidence in its suits against the American Bell Telephone Company.

Reply-Paid Telegrams.—After March 1 the value of an unused reply-paid telegram will only be refunded to the sender of the original telegram—that is, to the person who prepaid the reply—which only seems fair.

Coventry.—Considerable dissatisfaction is being manifested in some quarters in Coventry at the attitude of the Corporation, who it is considered wish to do nothing themselves with the electric lighting nor let anyone else do it.

New York Subways.—The Westinghouse Electric Light Co. now virtually controls the Subway Company of New York, by a consolidation of the interests of the Brush, Thomson-Houston, and Westinghouse interests in this city.

Deptford.—We understand that Lord Crawford has resigned the position as chairman of the London Electric Corporation, mainly on account of ill-health, in favour of Mr. Forbes, Lord Crawford still remaining a director of the company.

Fire Alarms.—Messrs. W. Blenheim and Co. have received an order to fix their improved system of street fire alarm telegraphs for the district of the Local Board of South Hornsey, also to rewire the telephone exchange and electric bell system at the St. Saviour's Union, Dulwich.

Sevenoaks.—At the meeting of the Sevenoaks Local Board last week, consent was given, subject to certain conditions, to the provisional order which the Electric Trust, Limited, are about to apply for, with a view of serving Sevenoaks. The matter had been previously considered.

Power Stations.—The West End Railroad Company of Boston are equipping their new station with 20,000 h.p. The new type of four-pole Thomson-Houston dynamos will be employed, each capable of yielding 200 h.p. This station is expected to mark an epoch in electrical engineering annals.

Insulating Staples.—A small point of detail in wiring is that of using insulating staples when running wire upon woodwork. Casing is now used universally, but occasionally covered or flexible wires have to be run, and the insulating staples should be employed instead of iron staples.

Morality and Electric Light.—M. Brousse has submitted a proposition to the Paris Municipal Council for the lighting of the Avenue de Clichy as far as the fortifications. This proposition has been supported by the Prefect of Police, who states the accidents and crimes are far too frequent in this locality owing to absence of sufficient light.

Barnsley.—At the Barnsley Town Council on Tuesday, the Park and Lighting Committee reported that they had approved proposed conditions of form of proposal to be entered into by companies proposing to supply electricity in this borough; and also that they had visited Halifax and inspected the electrical engineering works of Blakey, Emmott, and Co., and also the electric light in several shops, warehouses, and public places. The report was adopted.

Electric Railroad Telegraph.—A new arrangement for telegraphing on railways has been devised by Mr. Baylus Cade, Louisburg, North Carolina. This telegraph is made by a peculiar arrangement of circuits, sliding contacts, and electromagnets upon the train and at the various stations, operating upon the block system, to prevent one train from entering on a given section of track until the preceding train has passed off, and adapted to permit one moving train to communicate telegraphically with another or all the trains that may be upon the road.

Weymersch Battery.—An exhibition is now being given at Prince's-mansions, Victoria-street, of the Weymersch battery as a practical primary battery for electric lighting. A battery is shown in actual operation, and the ease of manipulation can be seen. A number of incandescent lamps of 10 c.p. and an arc lamp of 400 c.p. are all run off this battery, at a cost, it is stated, of ·4d. per lamp-hour for the incandescent, and 4d. an hour for the arc. We are compelled, from exigencies of space, to leave the full description of this interesting exhibit till next week.

Derry.—Last Friday afternoon the Derry Corporation held a special meeting to consider their position in relation to an electric lighting company seeking powers to establish itself in Derry for a house-to-house service, involving a right to use the streets and roads in the control of the Corporation. The attendance of members was small. After a discussion it was decided, by a majority of ten to two, that the Corporation itself apply for the provisional order. This is intended as a protective step merely. Many of the Corporation are heavy shareholders in the local gas company.

The Postal Telegraph Service.—A parliamentary paper issued yesterday gives an account of the amount received and expended on account of the telegraphic service in the year ended March 31 last. The gross amount received by the Post Office in respect of telegraphic messages, private wire rentals, special wire rentals, etc., was £2,310,327, the net amount being £2,129,965. The expenditure on account of salaries, rent, and maintenance of telegraphs was £1,969,323, and the balance to meet interest on stock and the redemption of the debt, after paying other expenses, was £88,003. 17s. 9½d.

International Joule Memorial.—A large and influential committee has been formed for the carrying out of the recommendation of the meeting of the Royal Society, of an international memorial to the late James Prescott Joule. A considerable number of names have been received as subscribing, amongst whom we notice the Marquis of Salisbury, Lord Rayleigh, Dr. Siemens, Sir Wm. Thomson, Mr. J. W. Swan, Dr. Hopkinson, Mr. W. H. Preece, and other well-known names. Subscription forms can be obtained of the hon. secretary, International Joule Memorial, Royal Society, Burlington House.

Signalling at Sea.—On Feb. 5th an interesting spectacle was witnessed at Toulon. The American squadron, says *Electricité*, while lying outside the harbour, made some experiments on signalling by means of incandescent lamps placed in the mastheads. The electric signals were dispatched from the cruiser "Chicago," under Admiral Walker, and were repeated with remarkable rapidity and correctness by three other vessels placed under his command. The success of the trials was greatly commended at a dinner given the next day by the French Admiral Duperré, prefect of marine, to Admiral Walker and his officers.

Electric Lighting of the Houses of Parliament. As we announced last week, the first step towards the entire lighting of the Houses of Parliament by electricity was completed ready for the opening of Parliament on the 11th inst. by the Westminster Electric Supply Corporation. The wiring and fittings inside the building have been carried out from the designs and under the supervision of Mr. Prim, the engineer to the Houses of Parliament, and the effect of the new light, more particularly in St. Stephen's Hall, is most striking. We are given to understand that the chief executive engineer of this company is Prof. Kennedy, F.R.S.

Electricity at Johannesburg.—We have several times insisted upon the extension that must be looked for in electrical engineering enterprises, if only the English electrical engineers would take the trouble to appoint representatives. We are glad to learn that Messrs. Woodhouse and Rawson have with this idea started a branch at Johannesburg on the Transvaal goldfields, and there is little doubt considerable results may be expected. Mr. R. Lewis Cousens, M.I.E.E., lately electrician to the Kimberley Corporation, has taken the management of this branch, which is to give considerable attention to heavy engineering as well as the lighter electric specialties of the company.

Long Distance Lighting.—An installation of an interesting character has recently been carried out in Derbyshire by Messrs. Verity and Sons, Covent Garden. This is of a gentleman's house situated one mile from a colliery. The energy is supplied from the colliery engine and transmitted to the house, but as the gentleman would have no high-tension current in the house, preferring rather to pay for cable, the communication was made with 19/14 cable a mile each way, the first part from the colliery to the grounds being overhead, and the latter part as soon as it enters the grounds dipping underground. The current is transmitted at 150 volts and charges a set of accumulators placed in the house.

Length of Arc.—Certain researches have been published by M. Villari upon the influence exerted by the nature of the surrounding gas upon the length of the voltaic arc. If this is represented by 3·9 (mm. ?) in hydrogen, it is 7·4 in oxygen, and 8·5 in ordinary air when the arc is kept in the horizontal position. If the position is vertical the length of the arc is greater, especially if the anode is at the top—that is to say, with a descending current. M. Villari gives the following figures: in oxygen with an ascending current the length of arc is found to be seven times that in hydrogen, but with a descending current the difference is far greater, being 25 times 7. The author attributes the difference to the heat developed by the anode.

Paper Pulleys.—Pulleys made of hydraulic-pressed pasteboard, and having an iron core and strong casing, are now supplied by the Maschinen und Armaturfabrik Klein, Schanzlin and Becker, Frankenthal. It is said that the friction of such pulleys is considerably greater than that of cast-iron pulleys, and with an equal useful effect they therefore take up less space. As the tension of belting on these paper pulleys need not be so great as on iron pulleys, the vibration is less and to that extent the buildings are saved. The manufacturers affirm that these pulleys are proof against water. They are made of the well-known oil paper manufactured by Messrs. Gebr. Adt, Forbach, of which paper railway wheels are made.

Electricial Activity.—A very good idea of the immense activity which seems now to be pervading the whole electrical field in England was gained from a chance call upon Mr. J. E. H. Gordon, who has recently taken offices, in fact, the whole house, at 11, Pall Mall, W. The house is very comfortably and handsomely furnished as drawing offices with a laboratory on the upper floor, and a large staff of draughtsmen and assistants are at work mostly upon central station work for all parts of the world. Besides this, Mr. Gordon has a new engine which is coming out shortly, of which very great things are expected, and also, an interesting item for electrical engineers, a new arc lamp practically without works and costing a mere nothing to make, but which has been well tested and found to act splendidly.

Electric Lighting in the French Provinces.—Electric lighting is making great progress in the French provinces. The firm of Buchin, Tricoche, et Cie., who have installed the electric light at Cuxac (Gironde), using a fall of water situated at Raouel, at a distance of 1¼ miles from the centre of distribution, have just carried out some very satisfactory tests. The waterfall, which gives 35 h.p., runs two Gramme dynamos, giving 83 amperes and 210 volts. The same firm are at present erecting a steam-engine of 60 h.p. to run two dynamos for 600 lamps in the town of Capestang (Herault). A small installation has just been started at Tancarville by the same firm, and the trials which took place on the 12th inst. were very satisfactory. This consists of a Pilon engine of 10 h.p., driving a dynamo of 40 amperes and 100 volts, which supplies 20 lamps of 16 c.p. and 12 lamps of 50 c.p.

Brighton Electric Railway.—Volk's electric railway at Brighton, says the *Sussex Daily News*, seems to have as many lives as a cat. It has been severely damaged again and again by gales; and it has not been without other enemies; yet, after every apparent fatal injury, it has soon recovered itself, and the electric cars have gone on their way rejoicing as usual. The last gale did very serious injury to the railway, twisting the rails at places into something like gigantic corkscrews, and carrying away many tons of beach from beneath the line. But once more the owners of the railway have triumphed; and, the damage having been repaired, the cars are once more running as usual. There is matter for congratulation in this. Besides being a decided advantage to residents in Kemp Town, the railway, by reason of its unique position among the railways of the United Kingdom, is distinctly an attraction to Brighton, and no one who wishes well to the town will wish ill to Volk's electric railway.

Resistance Frames.—One of the pieces of subsidiary apparatus which are required in installations are resistance frames for regulation. They are especially required when an arc lamp is wanted to be run parallel on an incandescent circuit. In ordinary practice at present these are often rather cumbersome pieces of apparatus, and to improve upon this a very neat and closely built resistance frame has been designed by Messrs. Poole and White. It consists of a cast-iron frame, on which porcelain insulators are mounted, filled with closely wound spirals of resistance wire, the whole not being more than 13in. high by 8in. wide. The specimen we saw was for 6 amperes 100 volts, and has contact screws giving 5, 6, or 7 ohms. Other sizes are being made for 10 and for 15 amperes. Metal covers will be fitted for outdoor use. It is intended to manufacture these resistance frames in standard sizes and keep them in stock, so that at any time a resistance is required for any London circuit these can be sent for and fixed at a day's notice.

Maxim-Weston Company.—Mr. J. Blades Gooding, the chairman of this company, writing to the *Financial News*, says the directors have discontinued salaries and fees amounting to nearly £1,000 per annum, and they have now several responsible travellers soliciting orders where not long since they had none. Mr. Swaby now holds no official position in the company, and has resigned his seat at the board, which now comprises Mr. John Marks, Mr. Couchman (original directors), and himself. The board have agreed to draw for fees less than one-third of the sum to which they are entitled under the articles of association. The company has established a central station at Dalston, and is now engaged in the manufacture of switches and other electrical appliances, and they hope to largely develop this branch of the business, and compete with all other manufacturers for the supply of the London and provincial trade. St. Margaret's-mansions are being wired and lighted from their own machinery, and other jobs are in hand.

Nikola Tesla.—The *Electrical World* for February 15 contains a portrait and biography of Nikola Tesla, the talented young electrician whose name suddenly came into prominence from the publication of his work on alternate-current motors. His native place was Smiljan, Lika, in the border regions of Dalmatia and Montenegro, touching Austria. His father was a clergyman of the Greek Church, and he himself was also destined to be a clergyman, but the fates and his own tastes ruled it quite otherwise. He graduated at Carlstatt in 1873, afterwards carrying on his studies at Gratz and at Prague under circumstances of considerable difficulty, taking a berth eventually as assistant in Government telegraph department at a pound or so a week to keep himself going. In 1881 he went to Paris and afterwards to Strasbourg. Then he crossed to America, where he applied himself with indefatigable vigour, and in 1887 the Tesla Electric Company was formed. It was soon after this that his celebrated paper on motors appeared. Mr. Tesla is 33 years of age, tall, spare, and refined, and he speaks at least half-a-dozen languages.

Ship Lighting in India.—Friday, the 17th Jan., witnessed the completion of the installation of the electric light on board the turret ship "Magdala," stationed in Bombay Harbour. Mr. A. M. Taylor, of Messrs. Siemens Bros., who was specially engaged by Government for the work, has during the past four months been engaged fitting up the electric light on both turret ships "Magdala" and "Abyssinia," and has made such rapid and satisfactory progress that he has completed his arduous and difficult task in something like two months less than is usually taken to do the work at home. Not only that, but he has been so far complimented in his work, that the officers in command assert the ships are the two best lighted now in the service. There are two search-lights on the "Magdala" of 25,000 c.p., and by them shipping can be discovered between two and three miles off, although for signalling purposes, which is done by throwing the light against the sky, it is stated that messages can be telegraphed to ships as far as fifty miles off. The installation was pronounced a grand success, for which all credit is due to Mr. Taylor.—*Indian Engineer*.

Inner Temple.—The extensions of the electric light installation at the Inner Temple have recently been inspected by Mr. Preece, acting as the consulting engineer, who has expressed himself as thoroughly satisfied with the arrangements. The installing of this plant was entrusted to Messrs. Drake and Gorham, who have put down a boiler capable of working up to 50 h.p., and a Willans engine coupled to a slow-speed dynamo. The arrangements to prevent noise have been so far successful that it is impossible when standing outside the engine-room to determine whether the plant is running or not. The installation now consists of two dynamos, three batteries, and two engines, one gas and the other steam. The switchboard is fitted throughout with Drake and Gorham's patent ring contact switches, and has been specially designed to enable all the batteries to be charged either separately or together from either dynamo; the lamp circuits can also be varied in the same way. The effect produced in the hall since the extension of the lighting is stated to be remarkably fine, and the comfort of electric lighting in the offices is especially appreciated.

Electric Fog Signal at the Bell Rock Lighthouse.—An explosive signalling apparatus has just been fitted up at the Bell Rock Lighthouse. The lighthouse is supplied, as it has been ever since its erection, with two large bells which are rung in foggy weather. The bells are still to be used, but it has been thought that a fog signal may also be useful both from the report and the flash of the explosion. The prominent feature of the apparatus now being used is a rod bent into a large hook at its upper end, which rises to a height of 18ft. above the lantern of the lighthouse, and is covered with insulated wire. The rod is attached with a worm screw to a revolving shaft inside the lantern, and when it is desired to charge it, the rod is brought down by working a flywheel with manual power. The hook end of the rod, by the working of the wheel, bends over and reaches the balcony, where it is charged with tenite, or gun-cotton cartridge and a detonator, and is fired by means of an electric spark. The fog signal has been fitted up under the direction of the engineer to the Commissioners of Northern Lights. Experiments are now being made with it. It is expected that it will be in full operation in the course of a month, and that during foggy weather it will be fired every ten or fifteen minutes. It is the first explosive signal which has been introduced in the lighthouse service in Scotland.

Westinghouse Stations.—The introduction into England at one stride of the largest Westinghouse station yet built—that at Sardinia-street—has naturally aroused the interest of electrical engineers who are anxiously awaiting further developments. Although Westinghouse has come to England somewhat late in the day, and therefore possibly has become looked upon a little in the light of an interloper, the machines are of course equally American with other acclimatised systems, as the Brush or the Thomson-Houston. The company, which has its offices in Victoria-street, Westminster, is a separate company to the American company, formed almost entirely, we believe, with English capital, and in which, therefore, English engineers and financiers are deeply interested. The second instalment of the Sardinia-street station for 15,000 lamps was added and completed some three weeks ago, making plant for 25,000 lamps of 16 c.p. Other undertakings are under weigh, and we think it will be interesting to state that at least three very large central stations—one being for 100,000 lights, the others for 50,000 and 60,000—may be expected to be heard of as to be begun before very long. One of these is for the Continent. Nothing has actually been done as yet with regard to the Westinghouse Works which were to be erected, though their erection has been definitely sanctioned, and the plans for works with all departments have been prepared.

City Lighting.—The Streets Committee of the Commissioners of Sewers at the last meeting brought up a report relative to the proposed contract with the Brush Electrical Engineering Company. The report said: "We have had under consideration the draft of the proposed contract with the Brush Electrical Engineering Company as returned by their solicitors, with various alterations and many suggestions made by them. The most important of the alterations are as follows: 1. That the option of renewing the contract for public lighting after the first twenty-one years for successive periods of seven years shall be mutual. 2. That the power of the Commission to purchase at the end of twenty-one years, or at each succeeding seven years, be limited to public lighting only. 3. That the receipts and expenditure in respect of the contract be debited with 5 per cent. interest on the capital, and a reasonable sum per annum for depreciation prior to arriving at the cumulative dividend of 10 per cent., and the application of the sliding scale as regards charges and profits. They say also that their clients think the contract must be conditional on their obtaining a provisional order giving them the necessary parliamentary powers over the district in question, and on their being able to obtain on reasonable terms all necessary way leases and powers to enable them to lay their mains outside the district to the points at which the main conductors may enter the district, and they suggest that the contract be executed, with a supplemental contract of the same date, making it conditional, as above stated, and providing that the required deposit of £1,000 be returned to them in case these powers cannot be obtained. The committee recommended the court to resist Nos. 2 and 3, and agree to the rest. The report was adopted.

Government Telegrams.—In the House of Commons on Tuesday, on the supplementary vote of £700 for Foreign Office expenses in regard to telegrams, Mr. Henniker Heaton said that a study of the estimates and appropriation accounts for the last ten years had convinced him that the growth of the telegraph expenses in all the departments had been rapid and uncontrolled. The increase of gross expenditure had been very great—in fact, it had in eight years doubled; and it was remarkable that year by year the estimates had been largely exceeded almost without exception in every department. The importance of the subject justified him in asking that an enquiry into the whole subject of telegraph expense in all Government departments should be granted without delay. The total expenditure on telegrams by the Foreign and Colonial Offices, by the Diplomatic and Consular services, and by the Navy during the ten years, 1876-77 to 1886-7, was £409,459, but the original estimates for these services only amounted to £239,400. They were now asked to vote £7,600 for extra expense incurred in telegrams for these departments, in addition to the sum of £13,400 originally voted. These sums were paid to a telegraph company for sending messages over lines to South Africa, which we now subsidised to the extent of £35,000 a year. He alluded to the company controlled by that monopolist, Sir John Pender, who in addition got a subsidy of £19,000 a year for a cable down the West Coast of Africa. He thought that this was not the time for raising the graver question whether the Government ought not, as a matter of State policy, and with a view to afford the public a cheap telegraph service throughout the Empire, to become possessed, by purchase or construction, of a complete Imperial telegraphic net. But in any case, he thought he was justified in asking that a committee be appointed to enquire into this large expenditure and the continual abnormal growth in Government telegraph expenses. The vote was then agreed to.

Mining Exhibition at the Crystal Palace.—The proposal which emanated from the *Mining Journal* to hold an international exhibition of mining and metallurgy at the Crystal Palace during the forthcoming summer has assumed important proportions. The Lord Mayor of London is patron, and the honorary president is the Duke of Fife. The list of honorary vice-presidents includes a large number of well-known names. Mr. W. Pritchard-Morgan, M.P., who has been so closely identified with the revival of gold-mining in Wales, is chairman of the executive committee. The scope of the exhibition will be sufficiently wide to enable a most valuable and interesting display to be made. Immense advances have of late years taken place in mining and metallurgical practice, and no wholly suitable opportunity has presented itself, or been taken advantage of, for adequately illustrating the degree of progress which has been attained, especially as regards the economical treatment of refractory ores for the recovery of precious metals. It is worthy of note that one-half of the surplus of the exhibition, as certified by the auditors, is to be paid to the exhibitors *pro rata* to the amount paid by them for space occupied, and the other half is to be disposed of by the council in founding a scholarship at the Royal School of Mines, or in helping some other institution connected with mining and metallurgy. The exhibition will open on 2nd July and close on 30th Sept., 1890, and besides several features of special attraction, important collections of exhibits are expected from the colonies and foreign countries. The honorary secretary is Mr. George A. Ferguson, editor of the *Mining Journal*, 18, Finch-lane, London, E.C., from whom prospectuses and application forms for space may be obtained. After electric lighting perhaps the most important application of electricity in England, awaiting the development of tramcar traction, is to that of mining and metallurgy, and we shall hope to see the progress which has been quietly made during the last few years thoroughly well represented in such an important field.

Electrical Purification of Sewage.—Since the experimental demonstration at Crossness of Mr. Webster's system of electrical purification of sewage, of which we gave a full description at the time, considerable discussion has been excited as to the practical application of the system for the treatment of sewage in towns. Surveyors and county councillors, as well as electrical engineers, have awaited with interest to see what steps would be taken for the further development of the system, which it was felt, if pecuniarily possible, would be a vast boon in large towns. We are able to give some further information this week as to the progress of the system. The works which were put up at Crossness were, as was stated, experimental, and as the use of an old-fashioned and cumbersome engine was somewhat deceiving as to the amount of power required, this has been abandoned and the station dismantled. In place of this, two serious experimental works have been undertaken in conjunction with municipal authorities, one at Salford and the other at Bradford. If the system is to be applicable at all, its greatest utility would be in crowded and difficult situations, and Mr. Webster has tackled the subject in one of its most difficult situations at Salford. The sewage from Manchester and Salford flows into the River Irwell, and as shortly (on the completion of the Manchester Ship Canal) the water of the Irwell will be turned into this canal, it is imperative to have this kept as far as possible pure of sewage. At present it pours into the in Irwell a thick, offensive stream, and it is to remedy this that an electric purifying station has been contemplated. The experiments have conclusively shown that 1,000,000 gallons in 24 hours can be treated by 30 h.p. The experimental station now established comprises a 4 or 5 h.p. engine. This drives a dynamo of a special type designed for the purpose by Messrs. Charlesworth, Hall and Co., of Oldham, and so far the station appears very satisfactory. The other experimental station is at Bradford, where a Siemens dynamo is used. We welcome these attempts to deal with this question—one of the most vast in human economy—in a business-like spirit, and we trust the outcome may be proved to be a success. More will doubtless be heard before very long.

Thomson-Houston Motors.—As our readers know, we have been harping in season and out of season—if there is an out of season—on the field that electrical engineers must find in electric motor work, a field which there is as great or greater scope eventually than even for electric light. England, of course, suffers from a want of central stations, though this is being overcome, but for electric motor work we equally suffer from the want of much more practically presented information such as will immediately appeal to the conservative and cautious men of business who do not know much about electricity. Show them motors at work, prints, photos, and descriptions of motors at work, show them the gain in ease, cleanliness, and space. The Thomson-Houston Company of America, than whom few have done more to spread the use of motors, have issued a splendid little presentation book illustrating the use of motors. Who would not appreciate the ink-photo of the engine labelled "For sale, cheap, in perfect order," at the side of which stands the little electric motor which has supplanted it in the good graces of Mr. Todd, owner of a printing establishment at Boston. Heavy work, too, is done by these motors: a large car for a mill tramway is shown carrying goods of four tons weight a run of 800ft.; a mining hauling plant with motor is shown working in place; a huge drawbridge, crowded with men and elephants to make up weight, as worked at Bridgeport, makes an effective illustration of the use of the motor, enabling the bridge to be opened by one man in two minutes against three men for six minutes on the old style. Another cut shows a printing office with machine delivering papers and the little motor away in one corner quietly supplying the power; another shows a whole machine shop with its network of belts and shafting driven by the same unobtrusive power. Smiths' shops, harness and saddlery shops, bookbinding works, sewing-machines for clothing factories, tobacco manufacturing, shoe factory, all these are shown with motors from 1 to 15 h.p., from actual photographs of the place printed from delicately-shaded and well-printed plates. Nothing could be better for the spread of a knowledge of the usefulness and handiness of the motor, and we congratulate the Thomson-Houston Company upon the issue of this little book.

Ellenborough Colliery.—Last week the Ellenborough Colliery, belonging to the Maryport Hematite Iron and Steel Company, was visited by several of the managers of neighbouring collieries and others interested in the electric light, in order to see the installation of electric light and power which has recently been erected by Messrs. W. T. Goolden and Company. In the dynamo-room, the plant consists of a two-cylindered engine driving the dynamo, which is of Messrs. W. T. Goolden and Co.'s special type for colliery work, capable of lighting 150 lamps. The machine is constructed throughout with a view to its being worked by unskilled men, and being required to run for long periods without attention. A neat switchboard is arranged with double pole cut-outs. The visitors next inspected the light in the different workshops and engine-rooms. The number of lights at present in use are 70 lamps of 16 c.p., three of 50 c.p., and two of 600 c.p., which light up the yard in a most efficient manner. The lamps in exposed places, such as the heapstead, screens, and pit bottom, are enclosed in a strong glass globe, which forms a damp and dust-tight protector, and prevents their being broken, while at the same time the strong globes are much more easily cleaned than the somewhat delicate lamp. Several of the visitors next went down the pit, and were extremely pleased at the brilliant light down there, which enables the men to carry on their work much more rapidly, with less risk of accident than they could with the old system of illumination. The party were then conducted to the dip where the electric pump is working, and its construction was explained to them. The motor and pump are mounted on one bed-plate, and form a very compact plant. The pump is a three-throw ram, one geared to the motor with spur gearing. This latter is of Messrs. W. T. Goolden and Co.'s special mining type, and is so constructed as to be safe in even fiery places. The whole of the revolving parts, armature, commutator, and brushes are completely enclosed in a strong metal air-tight case, so that should the brushes be badly set no gas can come near the sparks. Special care has been, however, taken in designing the machine to prevent sparking at the brushes, a matter in which they seem to have been very successful, as no sparking could be detected. This pump has now been running night and day for some time, a thing which was impossible with the old steam pump on account of the heat due to the steam. Altogether the installation appears to have been very satisfactory, and as nothing but the best materials have been used in its construction there is no doubt that it will continue to work very well. The contracting firm make a speciality of colliery and mining work, and besides electric light, pumps, and hauling machines, they manufacture electric coal-cutters, several of which are in successful operation in Yorkshire, and of which photographs were exhibited to the colliery managers interested in such machinery.

ELECTROLYSIS OF PLATINUM SALTS.

BY ALEXANDER WATT.

The importance of platinum as a coating for other metals has always been fully recognised, and many processes have been devised for the electrolytic reduction of the metal for practical purposes in the arts; but hitherto obstacles of a serious nature have stood in the way of success. The main difficulty has always been to obtain a bath or electrolyte which, under the influence of the current, would dissolve the anode, and thus keep up the normal strength of the solution. Indeed, this difficulty would appear to be insurmountable, for I find that even with acid solutions in which chlorine is freely given off at the anode, the liberated gas passes into the atmosphere without in the least degree attacking the platinum itself. It would thus appear that nascent chlorine has no solvent action on metallic platinum. With a view to determine whether the chlorine set free at the anode during electrolysis would dissolve platinum, a number of experiments were tried, but the results obtained were of a negative character. For example, strong hydrochloric acid was decomposed by the current from three Daniell cells in series, when an abundance of chlorine was liberated, but the platinum anode was absolutely unaffected. Again, solutions of chloride of sodium and potassium respectively were electrolysed, with a like result in each case. Nitro-hydrochloric acid was also electrolysed in the cold, but while chlorine was freely evolved at the anode the metal itself was untouched. A solution of perchloride of iron was next decomposed with the same current, when gas was freely liberated at both electrodes, but the chlorine set free at the anode did not produce any visible effect upon it.

Being deprived, therefore, of the functions of a soluble anode, by which the normal strength of the bath is ordinarily sustained, it becomes necessary, when we desire to coat other metals with platinum, to adopt some means by which the standard metallic strength of the solution may be uniformly kept up during the progress of electro-deposition. To effect this, constant additions of the platinum salt employed to make up the bath must be made so as to keep the liquid in a perfectly uniform condition while the deposition of the metal is going on. It is not sufficient to add an occasional dose of the concentrated platinum solution to strengthen the bath after an unknown quantity of the metal has been removed from it by the articles coated; but in order to ensure a perfectly uniform condition of the electrolyte—upon which the success of the operation chiefly depends—the solution must not be allowed to vary, so far as the proportion of its most important constituent is concerned, in any perceptible degree. If the original condition of the bath is not fully sustained, the character of the deposit will be seriously affected, and probably black, powdery, and non-reguline metal appear upon the articles already coated with a bright reguline film of platinum. This uniform condition of the bath can be best attained by a system of *circulation*—that is to say, there should be a vessel charged with the normal solution, placed at a convenient height above the depositing-tank, which, being provided with a suitable tap, will allow a continual flow of fresh liquor to enter the tank. An equal proportion of the partially-exhausted liquor of the depositing-tank must be allowed to continuously flow out of this vessel by means of a tap corresponding with the one employed for the normal liquor in the head tank above, and the partially exhausted liquor must be strengthened by an addition of the platinum salt, and in its turn transferred to the head supply tank. If, now, a hydrometer be kept constantly floating in each of the vessels mentioned, and the readings carefully noted, there will be no difficulty in keeping the electrolyte up to the standard point. The circulation thus set up will ensure uniformity of deposition, all other things being equal, and there should be no reason why—provided the bath be a good one—the deposition of the metal should be otherwise than satisfactory.

We now come to the consideration of the solution in which the articles are to receive the deposit of platinum. With a view to assist, if possible, those who may be desirous of coating articles with this metal in a practical way, I lately made a long series of experiments with solutions of various platinum salts, from some of which the reader may probably select a solution that will prove serviceable as a platinum depositing-bath. In the course of the experiments referred to it was determined to ascertain the behaviour, under electrolysis, of the respective salts with and without the admixture of other substances, and though some of the results obtained are perhaps more interesting than practically serviceable, their publication may be useful to those who may not have leisure for experiment.

For the purpose of preparing the various solutions hereafter described, a quantity of bichloride of platinum was first very carefully prepared by dissolving platinum in nitro-hydrochloric acid, assisted by heat, and as soon as the red fumes ceased to appear in the bulb of the flask, the liquor was evaporated in a porcelain capsule until a dense, thick fluid was obtained, at which stage the evaporating vessel was moved round and round, so that the heavy fluid might spread well over the interior of the vessel, and the acid become expelled by moderate heat only. At this point—that is, when the liquid ceased to flow—the porcelain vessel was moderately heated for a few moments, when the mass became perfectly dry. After cooling, the chloride was dissolved in distilled water and bottled for use.

1. *Solution of Bichloride of Platinum.*—In this experiment it was determined to ascertain whether, if subjected to certain modifications as to the strength of the solution and density of current, a solution of the bichloride of platinum *per se* could be rendered available as a depositing solution. For this purpose, as stated above, great care was taken to obtain a perfectly dry mass of the bichloride without reducing the salt to the condition of a protosalt. In the first trial the bichloride was allowed to absorb moisture from the atmosphere until a thick oily liquid was formed, a portion of which was then poured into a small dish, and the concentrated liquor thus obtained was then electrolysed with the current from three Daniells in series, a platinum anode and a copper wire forming the two electrodes. The object of this experiment was to ascertain whether, under such conditions, the platinum deposited would assume a crystalline form. The operation was kept up for some hours, at the end of which time a small oval block of metal was found to have formed on the end of the negative wire, and from its edges a few small crystals had sprouted, but they were not of sufficient size and growth to be of significance. A moderately strong solution of the bichloride was next prepared, and this was first tried with the current from three cells, when a very white film of platinum was received upon a clear brass plate, but the film soon darkened, however. The current proving too strong, one of the cells was disconnected, and a fresh plate inserted, which speedily became coated with a bright film of platinum of fair colour, but scarcely so white as when the stronger current was used. After a few minutes' immersion of the brass plate, a black deposit of non-reguline metal formed on its surface, when it was deemed advisable to greatly reduce the anode surface, a small portion only of the plate being allowed to dip into the bath. A newly-prepared brass plate was now immersed, which slowly became coated with platinum, and the film continued to remain bright and free from the black variety of deposit for a considerable time. After a while, however, the film became dull, and of a greyish colour, which was doubtless due to the solution being deprived of much of its metal, having become exceedingly acid—a condition very unfavourable for obtaining a good reguline deposit.

2. *Neutralised Bichloride of Platinum.*—To obtain a non-acid platinum bath, composed of a moderately strong solution of the bichloride, the liquid was neutralised by gradual additions of chalk, the mixture being kept well stirred after each addition. When the neutralisation of the liquid approached completion, the solution was heated to expel carbonic acid, and then again tested with litmus paper. A neutral bath being thus formed, it was allowed to repose for a time, and the clear liquor was then decanted and electrolysed with the current from two cells, but since the metal deposited rather slowly, a third cell was put in the series, after which the deposition proceeded more satisfactorily. It was found necessary, however, as in the former case, to diminish the anode surface, as there was a slight

evidence of the formation of black metal on portions of the plate. When a small portion only of the anode was immersed, the film retained its uniform character. It must be stated, however, that the deposits from this bath were somewhat less adherent than those obtained from the acid bichloride; this, however, might be remedied by keeping the solution or the articles to be coated with platinum in constant motion, which could be effected by the circulation system referred to. If a bath of this kind could be rendered available in practice it would not be very difficult to manage, as the chloride of calcium, which would accumulate in the solution when fresh neutralised liquor was being constantly run in, could readily be got rid of by means of sulphuric acid, which would throw down an insoluble sulphate of lime.

3. *Platino-Phosphate of Soda.*—A solution was prepared by adding a solution of the bichloride to a hot solution of common phosphate of soda, and the resulting yellow liquid was tried with the current from one Daniell cell, when a very slight deposit slowly formed on a brass plate. A second cell was next connected, when deposition proceeded promptly, and a good reguline and very bright film was obtained. If kept up to the normal metallic strength by fresh additions of the platinum salt, a very good bath might be made from this combination. It is necessary, however, to keep an excess of the phosphate of soda in the solution, otherwise the deposit is apt to assume the appearance of "blued" steel—a condition, however, that might be useful for colouring small ornamental articles. Instead of using an excess of ordinary phosphate of soda in making up this solution, the difference may be advantageously made up with pyrophosphate of soda.

4. *Platinum Bichloride and Sulphocyanide of Potassium.*—A solution of the bichloride was added to one of sulphocyanide of potassium, when a liquid of a deep orange-red colour was obtained. This was electrolysed with the current from three cells. A clean brass plate was then immersed in the bath, which soon became coated with a patchy film of metal, portions of which were bright and reguline, while the remainder was black and powdery. The deposit, however, was greatly improved by keeping the cathode in motion.

5. *Potassio-bichloride of Platinum.*—A warm solution of caustic potassa was first prepared, to which was gradually added a solution of bichloride of platinum, forming a pale yellow liquid. This solution was first tried with the current from two cells, but little or no deposit was obtained upon a brass plate. A third cell having been connected deposition gradually commenced, but the film was of an irregular and wavy character, and was, moreover, somewhat dark in colour. With a reduced anode surface, better results were obtained, especially when the solution was made moderately warm. As in most instances, in the electrolytic reduction of metals the colour, or tone, of the deposited metal is considerably influenced by the nature and strength of the electrolyte, and by the density of the current employed. A current of low tension will frequently give a film of dark colour, though perfectly reguline, while one of a higher E.M.F. will yield a deposit as white as platinum foil. The hardness of the metal, however, does not appear to be so much affected by the conditions referred to as is the case with most metals.

6. *Chlorides of Platinum and Ammonium.*—Weak solutions of the respective salts were mixed, and the resulting solution electrolysed with the current from two Daniells, when a film of rather darkish colour was soon obtained. The deposit was not very uniform in character, for after a few minutes the film became somewhat patchy. Better results, however, were obtained by keeping the negative plate gently in motion.

7. *Bichloride of Platinum and Hyposulphite of Soda.*—A weak solution of hyposulphite of soda was first prepared, to which was gradually added a solution of platinum bichloride. With the current from two Daniells no deposit was obtained, so a third cell was connected, when a film of platinum of a rather dark colour was received upon a brass plate. After a few minutes, however, the solution assumed a brown colour, and failed to yield a satisfactory deposit.

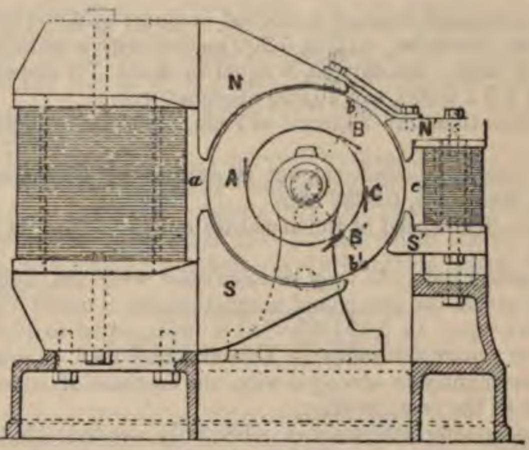
8. *Chlorides of Platinum and Sodium.*—To a weak solution of bichloride of platinum, one of common salt was added, and the resulting liquid tried with the current from two cells, but a very slight film only was obtained; a third cell was then put on, when deposition took place more freely. The film, however, was of an indifferent colour, besides being streaky and irregular. On the following day it was found that the salt had crystallised at the bottom of the vessel. The liquid being again tried, it still failed to yield a good deposit of platinum.

(*To be continued.*)

DYNAMO WITH COMPOSITE MAGNETIC FIELD.

The theory is given in an article which we translate from *Electricité*, of a special type of dynamo machine with composite magnetic field capable of supplying a regular output, either the E.M.F. or the current being kept constant when driven by engines running at irregular speed. The same principles will be found to apply to dynamos with composite magnetic field, which were here applied with a special purpose in view.

It was required for a certain installation of electric light at Borgenhout, Belgium, to generate two differential currents, the one compound at 205 volts, the other super-compound, or over-compounded—that is, varying from 205 up to 240 volts, according to the strength of this second current, these two currents being produced separately and simultaneously. The following is the means employed to obtain this result with a single dynamo.



The inductive system of the dynamo is composed of two distinct parts, as shown in the figure. The large electromagnet to the left is compound wound, and generates a constant E.M.F. in the portion of the armature which is influenced by its two pole-pieces—that is, the two portions $a\,b$ and $a\,b'$. The small electromagnet to the right is wound in series so as to generate in that portion of the armature, $B\,c$ and $B'\,c$, between its pole-pieces, an E.M.F. which varies proportionally to the strength of the current exciting it. The two upper adjacent pole-pieces, that of the large and that of the small magnet, are of the same sign, and thus form a single pole. It is the same with the two lower pole-pieces. The small magnet is fixed to the frame by means of a bronze casting so as to be magnetically insulated and separated from the large magnet.

The inductive circuit thus forms, together with the armature, a bipolar dynamo machine, with this difference that the magnetic field is divided into two distinct parts which act separately upon the armature. The upper interval, B, and the lower, B', between the pole-pieces of the large and the small magnet, give two neutral points on the armature which are at the same potential; the brushes, B B', pressing on the two corresponding points of the commutator as connected in parallel.

The first current, compounded for 205 volts, is collected between the two brushes B B' and the brush A to the left corresponding to the point a of the armature. On the other hand, the E.M.F. of the current collected between the two brushes B B' and the brush C to the right varies proportionally to the amperes which excite the small magnet from 0 to 35 volts; it therefore results that the seco current collected between the brush A, to the left, and the brush C, to the right, is over-compounded, so that the E.M.F. varies from 205 to 240 volts according to the strength of current. Of course it is the second current only which passes through the series coils of the small dynamo.

This dynamo is, as far as is known, the only one constructed in this manner, producing simultaneously two distinct currents for different purposes.

The figure gives a sufficient idea of the machine, of which the numerical conditions of construction and working are the following:

Capacity.—The strength of each of the two currents is essentially variable; the sum of the two currents may reach 70 amperes.

Variation.—The E.M.F. of the over-compounded current varies from 205 volts for 0 ampere, and increases by ½ volt per ampere (of the over-compounded current only) up to 240 volts when the current reaches 70 amperes.

Armature.—Pacinotti type: 243 iron plates with teeth, 1 millimetre ($\frac{1}{25}$in.) thickness; exterior diameter, 394 millimetres; length, 325mm.; useful section of iron, 466·56 centimetres; 72 coils of four turns; wire, 3·6mm. diameter.

Total resistance of armature, 0·113 ohm.

Field-Magnets.—Soft iron; section of compound magnet, 525cm.

Section of over-compound magnet, 112·5cm.

The pole-pieces of large magnet embrace 105deg. of the circumference of the armature; those of the small magnet embrace 25deg., and the intervals, *a*, *b*, *b'*, and *c*, also 25deg.

The compound magnet is excited in shunt by 6,000 turns of 1·2mm. diameter, making 6,900 metres, with a resistance of 103·5 ohms; the current is equal to about 1·8 amperes, making 1·8 × 6,000, say 10,000 ampere-turns.

In series there are 22 turns of 7mm.; resistance, 0·0115 ohm.

The over-compound magnet is excited by 80 turns of 7mm.; resistance, 0·0288 ohm.

Speed.—The speed of the armature is 750 revolutions per minute.

Magnetic Field.—As may be calculated with the figures already given, the compound magnet creates a useful magnetic flux equal to 5,594,000 C.G.S. units, equal to 10,840 units per square centimetre. This magnetic field of course increases slightly in strength with the increase of current because of the compounding.

The over-compound magnet, when fully excited—that is, when it increases the E.M.F. the full 35 volts for 70 amperes—creates a useful magnetic flux equal to 972,000 C.G.S. units, or 8,640 units per square centimetre.

In the armature the useful flux varies, therefore, from 5,694,000 units to 5,694,000 × 972,000 = 6,666,000 C.G.S. units according to the strength of the over-compounded currents.

The useful section of iron in the armature being equal to 466·56 sq. cm. the specific induction of the magnetic field therefore varies from 12,204 to 14,281 C.G.S.

It will be noticed that the magnetic field is relatively less dense in the over-compound magnet than in the armature. This is for the purpose of making the E.M.F. generated by the over-compound magnet increase in exact direct proportion as possible with the amperes (of the over-compounded current), which would not be possible if the magnetic field were nearer to its saturation point.

Armature Reaction.—In the same manner, the number of turns on the armature, and therefore the number of ampere-turns, has been reduced to the minimum in order to avoid as much as possible the reaction of the armature, especially the reaction of the compounded current on the small magnet.

It will be noticed that out of 288 turns of the armature there will be $288 \times \frac{260^\circ}{360^\circ} = 208$ turns belonging to the compound circuit, which can thus exercise at the maximum a reaction of 208 × 70 ampere = 14,160 ampere-turns.

Efficiency.—The foregoing data allow the electrical efficiency to be calculated. This efficiency naturally varies with the method of working.

When the current output is partially compound and partially over-compound, which is the normal case for this dynamo, the electrical efficiency is between 93 per cent. and 94¼ per cent. according to output.

The magnetic attraction of the pole-pieces on the armature gives a horizontal resultant in the direction of the larger magnet. The strength of this attraction has the value foreseen. The points of the pole-pieces were cut off for 2cm. near the point C, which has not sensibly modified the formation of the magnetic field.

This is, however, the only thing not left as designed in the construction of the dynamo, for which the time given did not allow of preliminary experiments to be made.

THE THEORY OF ARMATURE REACTIONS IN DYNAMOS AND MOTORS.*

BY JAMES SWINBURNE

(Concluded from page 155.)

The winding and design of magnets of motors has received but little attention. Suppose a motor is to run at constant speed on a constant-potential circuit. The shunt excitation is

$$\Omega_s = l_a\, B_{ao}/\mu_o + g\, B_{go} + l_m\, B_{mo}/\mu,$$

the suffixes *o* and *f* showing reference to full or no load.

At full load the armature induction must be reduced so that the full-load current passes. If E is the terminal E.M.F., and R the armature resistance, the armature induction at full load $B_{af} = B_{ao}\frac{E - C\,R}{E}$, and the gap induction is also reduced in the same proportion. The full-load magnetic potential of the field-coils is

$$\Omega_s +{}_m = l_a\, B_{af}/\mu_a + (\pi - \theta)\, n\, C/10 + g\, B_{gf} + l_m\, B_m/\mu_m \quad (8)$$

The alteration of the first and last terms makes so little difference to the value of $\Omega\ +{}_s$ or Ω_s that it may be disregarded. The full-load excitation is thus increased by $(\pi - \theta)\, n\, C/10$, and decreased by the difference between $2\, g\, B_{go}$ and $2\, g\, B_{gf}$. That is to say, extra field excitation is needed to counteract the back current-turns on the armature, and less excitation is needed to produce the reduced air-gap induction. If these are equal, the machine will keep constant speed when shunt-wound. In a small or slow machine the armature loss is large, in a large one the back induction is great. A small machine, therefore, needs backward-wound series coils, and a large one forward-wound. If $(\pi - \theta)\, n\, C/10 = g\, B_{go} - g\, B_{gf}$, the shunt ampere-turns needed at no load and full load differ only by the difference of excitation needed to magnetise the iron of the field-magnets and armature. Unless the machine is very small the difference in the armature and field induction is not important. It tends to make the motor run slower at full load, and this may be taken into account where very exact work is needed.

As the field induction in a motor is highest at no load, the area of cross section is

$$A = 2\, a\, b\,\frac{B_a}{B_m} + \frac{r\,\Omega_p}{M\, B_m} \quad . \quad . \quad . \quad . \quad (9)$$

it is thus somewhat smaller than in the case of the corresponding compound-wound dynamo.

As a shunt machine is simpler to make than a compound, and as a differentially wound motor may start backwards, shunt winding is preferable. Within wide limits of size constant-speed motors can be designed with simple shunt winding. All that is needed is to make Ω_b equal to $g\, B_{go} - g\, B_{gf}$ $\Omega_b = (\pi - \theta)\, n\, C/10$, and $B_g = \frac{2\, a\, b\, B_a\, \pi}{(a + d)\ (r + \frac{1}{2}\, g)\ \theta}$, where *d* is an allowance for fringe, and θ is also made a little large to allow for fringe. This gives

$$\pi\,\theta - \theta^2 = \frac{20\, a\, b\, B_a\, \pi}{(a + d)\,(r + \frac{1}{4} g)\, n\, C} \quad . \quad . \quad (10)$$

This appears complicated, but when the symbols are replaced by numbers for an actual machine, of course it is quite simple. It will be found that in very small motors this makes the pole angle too small, while in large machines the pole-pieces would embrace the armature so much as to cause excessive magnetic leakage and reversed induction under the trailing corner, unless the pole-pieces are designed to obviate this.

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* Paper read before the Institution of Electrical Engineers.

A properly designed direct-current motor has also the very convenient property of running at approximately constant speed, even if the E.M.F. on it varies. If the field and armature are not highly magnetised the armature induction varies approximately as the E.M.F. on the shunt. The armature induction, and, consequently, back E.M.F., of the machine thus varies as the E.M.F. on the mains, which is just the condition wanted for constant speed. A direct-current motor will therefore preserve approximately constant speed, not only with varying load, but also with varying E.M.F.

SMALL AIR-SPACE DYNAMOS.

There is a type of machine that has not yet been much studied; that is, the dynamo or motor in which the gap is kept small, being merely a mechanical clearance to allow the armature to rotate.

Obviously, as the air space is small, the magnets will need very little excitation, and there will be no waste field to speak of, so the magnets may be made exceedingly small and light, though that does not appear to have been generally realised. The Pacinotti is the best known form of this machine, the Brush being a good example. The drawback to the Pacinotti armature is that it gives rise to Foucault currents in the field-magnets, and for that reason it is not generally used now, though the difficulty is sometimes overcome by making the teeth small and numerous.

Machines with the armature wires wound through holes near the periphery have been made on the Continent, but apparently with the view of increasing the armature induction by reducing the air space. This form, however, admits of very small field-magnets with very little excitation, so that it is specially adapted for machines where extreme lightness is needed.

At full load, however, a trouble arises in small-gap machines. As the air space is very small, the cross induction is very great, and so the induction under the leading pole corner is reversed. Of course, there is a position of the brushes with no sparking, but it is very far forward, more especially if the speed is very slow, as the self-induction of each armature section is then considerable. The result is that the back current-turns are very great, and so the field-magnets necessary for full load are not so very small after all. If the dynamo is running at a very slow speed—such, for instance, as a motor on a tramcar at 200 or 300 revolutions—the brushes may be allowed to spark, as the sparking will be small, and given no lead, or just enough to preserve constant speed. This form of machine is suitable for the application of reversing pole-pieces. It was shown that in any ordinary machine the difficulty of designing reversing pole-pieces arises from the difference of magnetic potential between the pole-pieces and the armature. In this machine the difference is very small, so reversing pole-pieces can easily be applied.

In the case of the Brush machine the cross induction is enormous, and the back current-turns are, therefore, enormous too. The result of this is that the lead of the brushes is very great. Such a machine may be short-circuited without any dangerous increase of current. In fact, it has been used for charging batteries for train lighting at varying speeds. As the speed increases the current tends to increase, and reduces the armature induction enough to keep the current within safe limits, even if the speed is increased several fold.

The excessive heating of the trailing pole corner in the Brush machine has given rise to many speculations. It has generally been assumed that the heat generated there is no greater than at the leading pole corner, but that it is additionally heated by the hot air from the armature. It is more probable that the excessive heating is due chiefly to increased Foucault currents. As the brushes have considerable lead, the coil leaving the trailing corner is not in parallel with the other, so that the heating by Foucault currents in the trailing corner would be nearly four times as great as under the leading corner where two coils are in parallel. The iron is probably too highly magnetised to allow the induction to vary quite so much as this, and as it is cast iron the resistance prevents the heating being still greater. The trailing corner is also very highly magnetised, while the leading probably has its magnetism slightly reversed. The heating from variation of magnetisation at the trailing pole corner is thus much greater, especially when the enormous magnetic force is considered, and the frequent passage of the armature notches. A 40-lighter has something like 120 per second.

As a Brush machine has very little air space, the shunt is very small, so that the compound machine is chiefly wound with series wire.

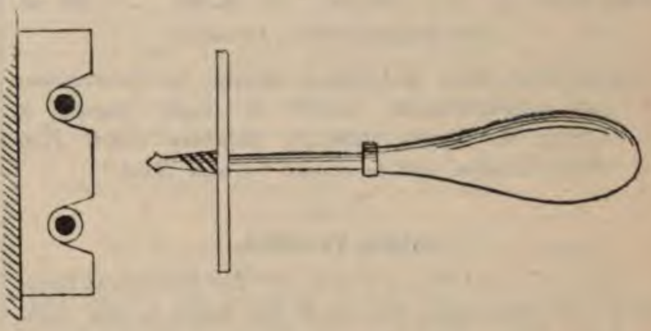
CORRECTION IN TESTING GRAMME MACHINES.

In the method of testing machines by running them as motors at no load, the machine is run as a motor with the armature induction the same as at full load. The power taken to drive it gives the stray power—*i.e.*, the loss of conversion. To this is added the loss by resistance in the armature and fields, and the efficiency of the dynamo or motor is thus calculated. The stray power consists of loss by mechanical friction, the loss by reversal of magnetisation, and loss by Foucault currents, and it has been assumed that these remain constant if the armature induction is constant. The theory of armature reaction, however, points to a few corrections. The loss by Foucault currents in the armature conductors is greater at full load than no load, by at most 33 per cent. The loss by reversal of magnetisation may also be slightly greater, as the induction in some parts of the armature may be greater. The loss by Foucault currents in the discs is slightly greater, but as this loss is exceedingly small, that does not matter. These increased losses are of little more than theoretical importance, but it is as well to point them out. If the machine is a large Gramme, the heating in the centre is largely increased at full load, so this method of testing does not give perfectly reliable results in the case of such large machines. For small machines and large drum machines it is very convenient.

This paper has been devoted to direct-current dynamos, as the corresponding treatment of alternating-current machines is perhaps hardly ripe for discussion yet, though it is of enormous importance, as the whole theory of running machines in parallel, and of alternating motors, depends upon it.

WIREMAN'S HAND CLEAT.

A little tool for a wireman, which promises to be very useful, is illustrated herewith. It is the invention of Mr. Fred. Bathurst, who has found the difficulty which men experienced in wiring houses. In the ordinary way, especially in turning corners, the wire has a great tendency to fall out of the casing. The method usually adopted is to cut up casing and nail it temporarily to the fixed casing to keep in the wire. This has several defects; it spoils casing, takes time, and requires two men, one to hold the wire while the other nails it. The wireman's hand cleat is meant to be manufactured in quantities, and as an ordinary bradawl, each workman to have several in his bag. It is practically a bradawl with an iron cross piece. This, when stuck into the casing, holds up the wire. The wireman can do this with one hand as he runs the wire, taking them out one after the other as the casing lid is fixed on. It would probably be worth while for some tool manufacturer to take it up as an ordinary tool.



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A THEORY.

"I have a theory" is a phrase often spoken, sometimes with a modicum of justification for it, sometimes from force of habit and without any justification. Technical papers are supposed to promulgate, analyse, and propound theories, hence we suppose the reason for some kind friend sending us a copy of a book entitled "From Cloister to Altar," carefully turned down, and duly marked with bright blue lines at a certain page. Our thanks are due to the unknown friend, but our hearts are obdurate, and our reasoning faculties, such as they are, refuse to accept the theory propounded to the Professor.

"Now, look here, Professor," says the book, "I have a theory, and, what is more, I believe it to be true. I believe that heat represents merely a mode of the operation of force upon matter. I believe light represents the existence of force without matter. When matter gets surcharged with force—that is, over heated—light is given forth ; the force, so to speak, leaves the matter and travels on its own account."

This beats the wandering Jew. Just fancy, light is force travelling about on its own account. We are sometimes hard upon professors and schoolmen, and, perhaps, do not always wait to say that our diatribes are levelled against the ninety and nine and not against the one. As Jack, Tom, and Harry style themselves professors, and no stand has been made against the adoption of the title, we are apt to dub the whole teaching tribe professors. Any remarks, however, that we have ever made must be as music in the ears of the pedagogues, to those of the holders of the theory referred to. Once more we are to have space—empty space—through which, however, we presume "force" or "light" can travel. Better the corpuscular theory than this.

Shade of Maxwell, come forth, combat this desire to "look backward," and keep electricians at all events steadfast in the paths indicated in the last sentence of your "classic" volumes. "Hence," says Maxwell, "all these theories lead to the conception of a medium in which propagation takes place, and if we admit this medium as an hypothesis, I think it ought to occupy a prominent place in our investigations, and that we ought to endeavour to construct a mental representation of all the details of its action, and this has been my constant aim in this treatise."

If Maxwell's mantle has fallen in part upon any one of the younger generation of professors, that one may well be taken to be Dr. Lodge, and, at all events, he will be found following Maxwell's footsteps, and endeavouring, not only to construct mental representations, but goes further and constructes apparatus to give concreteness to the mental figures.

It may only be in our imagination, but we take it this book was sent with the marks against the theory put forth to suggest a similar theory for electricity and magnetism. We have no tendency, we never had any, and trust we never may, towards "action at a distance." The idea seems absurd upon the face of it, and to fancy forces existing in empty space without matter is a greater burden than can be borne. It is because the term "induction" implies, or seems to imply to the ordinary mind, the idea of action at a distance that it is avoided whenever possible. So engrained, however, are certain terms into the literature of our subject that it is impossible to avoid them. Of course *the* Professor explains by references to strains and stresses in the medium. He does not imagine action at a distance, but has always in view the connecting link, though at times he is prone to jump from one side of his connective medium to the other without duly considering the leap he asks his hearers or his readers to take. Is not this an idiosyncrasy of the mathematician of which Todhunter ofttimes gave excellent examples? In the solution of the problem familiarity with the subject leads to the skipping of intermediate steps and stating the result is "so-and-so."

The immortal Faraday in his conception of "lines of force," "fields of force," gave to his contemporaries and to posterity a splendid weapon for constructing a "mental representation" of what he wanted them to study, and there is no doubt this suggestion has been of incalculable practical service.

There are two ways of looking at attempts to theorise, and the sooner it is fully understood that the student in his laboratory has a different aim to the practical man in his workshop, the sooner will some of the trammels that hinder progress be removed. While the student is anxiously groping after the why is this? the practical man is as anxiously seeking the how shall we utilise for the service of men what we now know. If he waited on the student's success, he would wait to the millennium, for theories are changing, and must change with the progress of knowledge. Every theory is in the most unstable equilibrium, and will be till *all* things concerning the subject are known. There is as little finality to the formulæ put forth by theorists as there is to the range of mind. A theory is interesting just so far as it assists in practical work. A theory of empty space is bad enough, but forces in empty space meandering about at their own sweet will makes the theory wholly untenable.

We wonder if it is because Englishmen are apt to take hold of some "mental representation" in all their investigations, to think more as physicists, that has put them for many years in the forefront of makers of machinery. Other nations have followed afar, and require to be shown before being able to construct good machines. What a libel it is upon the workers of the last fifty years to hear the spouters and stump orators of the day bewailing the decadence of England's ability to produce manufactured goods. Technical schools are to regenerate the country, according to the cry of those who want berths for their cousins or their aunts. Why, we have taught the nations how to work, and because they have copied us to the paint upon the pipe stack, it is dinned into our ears that we have gone back, and are not so good as we ought to be. No doubt; but let us tell these men who pretend to the knowledge they have not, that there is no single case of manufacture but that better goods can be provided in England than in any other country under the sun. There now, is not this a sheer case of being led away with "I have a theory"? Well, the theory is changeable, it is not fixed, and is not to be defended at all hazards. It is only another way of saying the "proof of the pudding is in the eating." We remember the late I. Todhunter taking part in the discussion upon modern geometry, and he offered to produce proofs of his contention about mathematical ability in England. We imagine that so far as our own industry is concerned, there can be produced at this moment, man for man, as many men in England as there are in the whole world besides who can design and construct machines as well adapted as may be required for any specified purpose.

CORRESPONDENCE.

THE ETHER OF 1839.

To THE EDITOR OF THE ELECTRICAL ENGINEER.

SIR,—I sent Dr. Lodge a copy of the first part of my book entitled "The Ether Theory of 1839 is the True Theory of the Leyden Jar." Having received from him a letter which I saw might do good if published, in that it would give editors and others freedom to write without bias on the subject, I requested Dr. Lodge's permission to publish it, and as he has consented I send you a copy.—Yours, etc.,
JAMES JOHNSTONE.

8, Merchiston-park, Edinburgh, Feb. 20, 1890.

[COPY.]

"21, Waverley-road, Liverpool, Feb. 15, 1890.

"To James Johnstone, Esq.

"Dear Sir,—I am indebted to you for a pamphlet in which you subject my little book, 'Modern Views,' to a criticism which cannot but be wholesome. It depends on what is meant by 'Electricity passing through glass.' In a sense it certainly does, but not by conduction. I expect you have got hold of a true idea in connection with the matter.—Yours truly,

(Signed) "OLIVER J. LODGE."

TRACTION.

To THE EDITOR OF THE ELECTRICAL ENGINEER.

SIR,—The following appears in your contemporary, *Invention*: "An electric locomotive of somewhat novel design has just been built at the New York Locomotive Works, Rome, N.Y., for H. W. Darling. The storage system is used, the batteries occupying what would be the firebox in an ordinary engine. The reciprocating move-

ment of the pistons is caused by currents in helical coils wound about the cylinder, the construction being founded upon the principle that an iron plunger will be drawn into a coil of wire through which an electric current is passing." As your paper is an authority on the subject of electric traction I should like to know how this is going to be, as the batteries are very heavy and give little power. "The inventor claimed that it will run on all roads where steam is used, and weigh 15 tons." This will be found in the *Electrical Review* (American) of December 22nd, 1888. If this is true, I hail it with delight, as it would be one step nearer towards solving the problem of independent traction.
Yours, etc., A. M. BUSHELL.

36, Queen's-road, Bayswater.

COAD'S BATTERY.

TO THE EDITOR OF THE ELECTRICAL ENGINEER.

SIR,—Mr. A. W. Bennett, of Leeds, who states he is a constant reader of your valuable paper, and imagines he knows something of coal-mines from a "frequent mile or more walk in the underground roads" (thus evincing a decidedly eccentric taste in his habits of peregrination for the benefit of his constitution), makes some remarks on the above subject "for the benefit of whom it may concern," which expression, although it sounds philanthropic, evidently displays the "*anguis in herbâ.*"

He states that a lamp for use in a mine must weigh less than 5lb., "as he has been told by an experienced mining engineer." I should like to know who is his authority? I broadly contradict it upon authority which I am sure is better than his, as it emanates from many mining engineers.

In the first paragraph of his letter he supports the theory of using oil *v.* electricity, but omits to state that no oil lamp in common use in mines gives more than ½ c.p., whereas my lamp with lens gives 10 c.p.

Then, again, he unfavourably compares the prices. Although, having regard to the superior light the primary lamp on my principle gives, I consider his deduction false, yet, looking at the question from a humanitarian point of view, every colliery owner first considers the safety of the miners and his property, and the price is of secondary importance.

This gentleman is evidently a partisan of the secondary battery system, with its steam-engines, boilers, beltings, charging, and endless costly details of working. He probably has a pecuniary interest in the system. (Do I remember him in connection with an iron battery of which he himself was the only admirer and user? He will correct me if I am wrong.)

Mr. Bennett concedes that primary batteries will come into use in the near future. All logical men who know anything at all about electricity are perfectly cognisant of the fact that the simplest of the secondary batteries and lamp must weigh more than a primary, and in practice it weighs about 9lb. as against 3½lb., the weight of the smallest battery I have yet made. I may say that I have obtained 18 hours' incandescent light from a four-cell oblong battery, weighing 4lb., averaging ½ c.p., magnified to an average of 10 c.p. by my patent lens, and I am in hopes to give a lamp weighing less than 3lb. to do the eight hours' shift.

In the next paragraph of his letter, Mr Bennett's gratuitously offering unsought advice as to the financial working of my patents I recognise as a rival's touch to depreciate the value of my work, and treat the suggestion as it deserves to be treated emanating from a suspected source.

With regard to my lens I could convince your correspondent by explaining how the result I claim is arrived at by a simple mathematical rule, but I am content to rely upon the subjoined letter from Messrs. Alexander Wright and Co.

As a word of general complaint, and in some measure appeal to my fellow-workers, and for their information, I should like to say what I have done. For a number of years I have worked solely in the perfecting of my ideas. Then at a certain stage of completion third parties with rigorous scrutiny investigate what I have done, and call in the best known professional men to pronounce. The opinion being favourable, certain publicity follows. Immediately the army of the disappointed rivals, cavillers, and contemptible doubters and failures commence fault-finding, and the more bold or least known air their views. By-and-by they will get to doubt my very existence. I consequently repeat only the general invitation I have given to everybody—"Come and see for yourselves."—Yours, etc., THEOPHILUS COAD.

31, Soho-square, W.C., February 25, 1890.

[COPY.]

"Wright's Gas Apparatus Manufactory,
"36, 38, and 40, Millbank-street, Westminster,
"February 25, 1890.

"Dear Sirs,—In accordance with your instructions we have again tested Coad's patent miner's lamp so far as relates to illuminating power. The lamp used was a 9-volt Edison and Swan, and the result, when tested on a Bunsen photometer, was 1·53 candles. The lamp was then placed in Coad's patent safety lamp, fitted with his patent facetted parabolic prism, and the result was 33 candles, the rays forming a concentrated beam of light, having an angular diffusion of 18deg. from axis of lens.

"We trust this result will be satisfactory to you, and remain,

"Your obedient servants,
"ALEX. WRIGHT AND CO."

SOME POINTS IN DYNAMO AND MOTOR DESIGN.*

BY W. B. ESSON, MEMBER.

Though the recent progress in dynamo construction has been of a highly satisfactory character, there still remain several points affecting design which have received but inadequate attention, and to which reference is seldom made outside the drawing-office. In the present paper a few of these unsettled points will be brought before the Institution, in the hope that a full discussion will enable us to make some progress towards a solution of the various questions raised.

1. MAGNETISING FORCE FOR A SIMPLE MAGNETIC CIRCUIT.

Foremost amongst the factors which have contributed to the progress of recent years has been a more perfect comprehension of the laws of magnetic induction, and now, knowing the magnetic properties of the iron with which we deal, it is a perfectly easy matter to determine the magnetising force required to produce in any simple magnetic circuit of given configuration a specified induction. The formula of Drs. J. and E. Hopkinson, which was published in the *Philosophical Transactions* in 1886, is now adopted by most designers who desire to economise their time. Reduced to ampere-turns, this formula for the magnetising force is

$$A_1 = L f\left(\frac{N}{a}\right) + L_1 \cdot 8 \, \frac{v_1 N}{a_1} + L_2 f\left(\frac{v_2 N}{a_2}\right) + L_3 f\left(\frac{v_2 N}{a_3}\right) + \ldots$$

Here A_1 is the magnetising force; L, L_1, L_2, and L_3 are the mean lengths, in centimetres, of the separate parts which constitute the magnetic circuit—comprising in this case armature core, air gaps, magnetic limbs, and yoke—while a, a_1, a_2, and a_3 are the cross-sections, in square centimetres, of these several constituents. Owing to the spreading of the induction, it is necessary to assume the air gaps as having an extension beyond the polar area equal to ·8 of the distance between the armature core and the polar surface. Of the induction produced in the magnet cores, only the portion N, which passes through the armature and is enclosed by the coils at the brushes, is serviceable, the lines of force which choose a path outside the armature constituting a stray field which cannot be utilised. In the above expression, v_2 is the ratio of the induction in the magnets to that in the armature, the total lines induced being therefore v_2 N. Since in cylinder armatures some of the lines stray through the internal opening, in these the induction in the air gaps will be greater than N. If we call v_1 the ratio of the lines in the gap to the lines in the armature, the lines in the former will be v_1 N. The functions $f\left(\frac{N}{a}\right)$, $f\left(\frac{v_2 N}{a_2}\right)$, etc., are read directly off the curves, Figs. 1 and 2, where ordinates give the induction per square centimetre, and abscissæ the corresponding ampere-turns required per centimetre length. These curves are reduced from the results of Dr. John Hopkinson.

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* Paper read before the Institution of Electrical Engineers, Feb. 20, 1890.

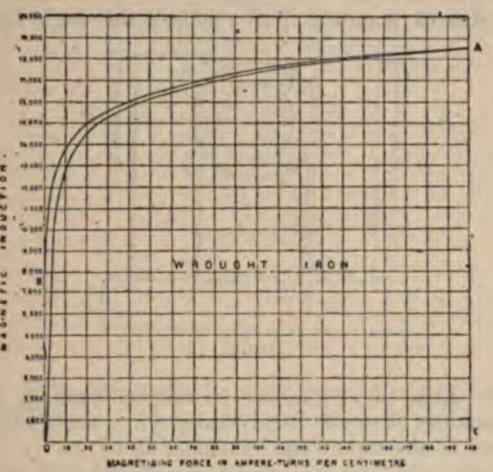
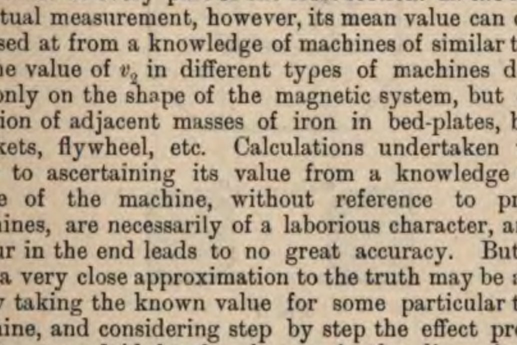


FIG. 1.

2. MAGNITUDE OF THE STRAY FIELD.

The expression in 1 gives a general formula for any configuration of magnetic circuit, but in order to employ it, we require to know the values of v_1 and v_2, or, in other words, we must know the magnitude of the stray field. To be quite accurate, we should know the exact distribution of the field, for in any particular machine v_2 has evidently a different value at every part of the cross-section. In the absence of actual measurement, however, its mean value can only be guessed at from a knowledge of machines of similar type.

The value of v_2 in different types of machines depends not only on the shape of the magnetic system, but on the position of adjacent masses of iron in bed-plates, bearing brackets, flywheel, etc. Calculations undertaken with a view to ascertaining its value from a knowledge of the shape of the machine, without reference to previous machines, are necessarily of a laborious character, and the labour in the end leads to no great accuracy. But I find that a very close approximation to the truth may be arrived at by taking the known value for some particular type of machine, and considering step by step the effect produced in the stray field by the changes in the dimensions and shape. It must be remembered that no two machines of the same type have exactly the same value of v_2 unless their dimensions correspond in every particular. Every alteration to the patterns, and every modification in the detail, introduce a new value for this ratio. Our calculations, therefore, must be to a great extent guesswork. We cannot help it. If the guess is a good one, we congratulate ourselves on the soundness of our judgment, or on the accuracy with which we make our calculations. If it is a bad one, we write to the forge about the annealing of the iron.



Magnetising Force in Ampere-turns per centimetre.

FIG. 2.

The values of v_2 have been ascertained for the following machines, and it will be found, probably, that for all modern types they lie between these limits. With these values to guide us, we cannot go far astray in new designs.

TABLE I.—*Stray Field in Different Dynamos.*

Name of machine.	Field.	Armature.	Remarks.	Value of v_2.
Edison-Hopkinson	Single magnet, 2-pole	Drum	Poles next bed-plate	1·32
Siemens	Single magnet, 2-pole	Drum......	Yoke next bed-plate	1·30
Phœnix	Single magnet. 2-pole (Fig. 8)	Cylinder...	Yoke next bed-plate	1·32
Phœnix	Double magnet, 2-pole (Fig. 3)	Cylinder...	Horizontal	1·40
Manchester...	Double magnet, 2-pole	Cylinder...	Bed and one pole cast together	1·49
Victoria	Double magnet, 4-pole	Ring	Ordinary pattern	1·40
Ferranti	Double magnet, multipolar	Coreless disc	Ordinary pattern (alternating)	2·00

The measurements of the Edison-Hopkinson and Manchester machines were made by Drs. J. and E. Hopkinson, of the Victoria by Mr. Mordey, of the Ferranti by Dr. W. E. Sumpner, and of the Phœnix by myself.

When the linear dimensions of a machine are increased in the same proportion, v_2 remains approximately unaltered. Suppose, for example, that all the dimensions of a magnetic system are increased n times. If the induction per square centimetre is the same, the total flux of lines is n^2. The cross-section of all the paths for stray lines are increased to n^2, and the distances between adjacent surfaces are increased n times. The lengths and cross-sections of the stray paths are therefore increased in the same proportion as the useful paths, and the ratio between useful and useless lines is unchanged.

If, the length of the magnetic circuit remaining the same, both dimensions of the cross-section are increased n times, making the area n^2, the total flux through the machine is n^2; and since the cross-sections of the stray paths are n^2 times greater, the value of v_2 remains as before.

If the length of every part of the magnetic circuit is increased in the same proportion, while the cross-section remains the same, v_2 is increased somewhat, owing to the increase in the cross-section of the stray path. If the dimension of either factor of the cross-section is increased, while the other is unchanged, and the length of the magnetic circuit remains the same, v_2 is reduced, its reduction depending upon the ratio of the two factors of the cross-section.

As the exact value of v_2 is a matter of some doubt until the machine is built, it may be instructive just to notice upon what the difference in the calculated flux through the armature, and the actual flux as modified by an error in the estimation of the stray field, depends. Assuming that we can measure accurately the path of the induction in the armature, often a matter of uncertainty—the magnetising force for the armature and the air gap can be determined independently of the magnitude of the stray field. The magnetising force to be allowed for the magnets depends, however, on the amount of stray field we assume. Imagine that in designing the machine we estimated a certain value for v_2, which turns out when the machine is built to be too low. Now, the reduction in the flux through the armature due to this error will depend upon the magnetising force required for the magnets as compared with that required for the rest of the machine, and on the difference in the magnetising forces necessary for the induction in the magnets under the real and assumed values of v_2. If these two quantities are large, the error will be considerable, increasing as the magnets are more saturated, and as their resistance in proportion to the other components of the magnetic circuit increases. If the difference in the magnetising forces for the real and assumed values of v_2 is small, the converse holds good, the error being small in proportion. In the Edison-Hopkinson machine, for instance, the magnetising force required for the magnets is rather over one-eighth of the whole machine, and the value of v_2 is given in the table as 1·32. If in this machine an erroneous value of 1·25 had been estimated in designing, the diminution of the flux through the armature, with the calculated ampere-turns so allowed for, would be only 2 per cent.; *i.e.*, the machine, to give the same output, would have to run at 765 revolutions instead of 750. If the magnets were saturated to a greater degree, or constituted a larger proportion of the magnetic resistance, the error would be correspondingly greater.

It must be noticed that the values in table I. are given at the working saturation of the machine. As the bending in the magnetisation curve of the iron becomes more pronounced v_2 increases. In actual machines we work above the bend, and with a reduced saturation v_2 would be less than given in the table. In practice, differences in the quality of the iron lead to much greater errors than are likely to arise from an error in the estimation of the stray field.

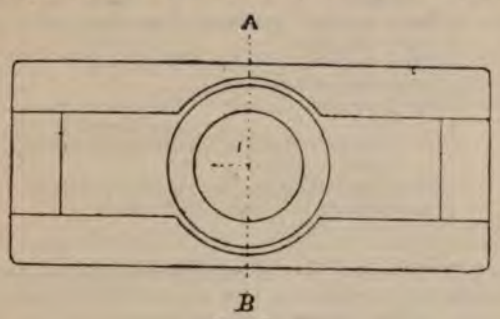


Fig. 3.

3. Symmetry of the Field.

It is of some importance to obtain a symmetrical field through the armature, as it is only when the field is symmetrical that the armature is electrically and magnetically balanced. Looking at Fig. 3, it will be observed that a line, A B, drawn diametrically across the armature divides it into two halves, which are perfectly similar as regards distribution of field; and, generally, this is true of all machines in which there is a double magnetic circuit. There is here no tendency of the armature to move laterally in the field, provided its centre is concentric with the bore of the polar cavity. But with single-magnet machines it is different. In Fig. 4, for example—which is about the worst form of magnet, on account of the section being reduced at *b* to half what it is at *a*—there is a strong upward magnetic pull, producing an abnormal pressure on the bearings, which may under some circumstances lead to serious trouble from heating. Most makers of single-magnet machines have experienced some trouble from this cause, and have adopted, with more or less success, some means of curing the evil. A remarkable instance of the heating due to magnetic pressure on the bearings was recently brought to my notice by M. Heilmann, of the Société Alsacienne de Construction Mécaniques, of Belfort. In the inverted machines first constructed by this company, the magnet cores, Fig. 5, were of wrought iron, on the top of which were fitted cast-iron pole-pieces, of comparatively small mass. From the look of the thing one would expect a very considerable downward pull, and in the case of some machines of 60,000 watt capacity the pressure on each bearing due to magnetic pull reached the high figure of 1,500lb. This, of course, led to serious heating, and in later machines the cylindrical wrought-iron cores have been continued to the top of the machine, as shown in Fig. 6, being fitted with cast-iron shells, which, together with the wrought-iron limbs form, when bored out, the polar cavity.

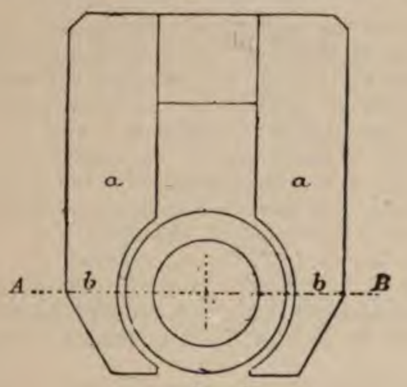


Fig. 4.

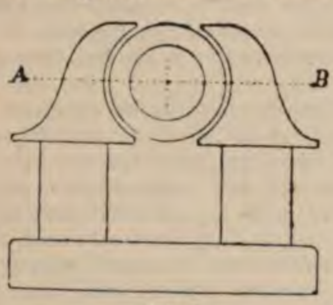


Fig. 5.

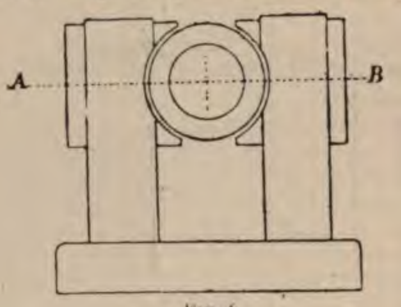


Fig. 6.

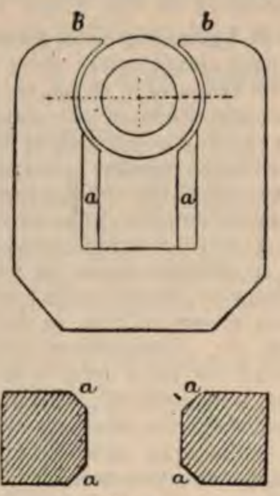


Fig. 7.

It will be noticed that the reduction in the section of the wrought iron due to boring out is very small, and I am informed that in this design the evil of heating has been completely abolished, a practically symmetrical field being produced. These machines are of the drum type.

In well-designed machines of the single-magnet type there need be no trouble, however, from magnetic pull on the armature. The first essential is that the section at the thinnest part of the magnet be reduced as little as possible. The form in Fig. 6, for example, where this is carefully attended to, may be cited as an example of good design; while that in Fig. 4 illustrates a magnetically bad design. Since the induction always takes the path of least resistance, the importance of keeping up the full section of the limbs at the poles, in order that the resistance due to

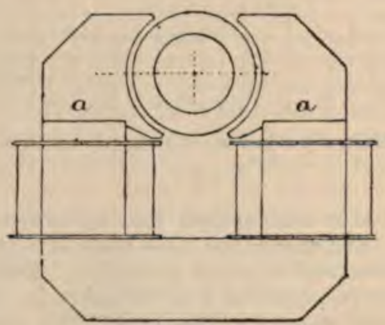


Fig. 8.

saturation may not cause unequal distribution of the field, will be obvious.

The magnetic pull may be balanced by the very simple device of placing the armature eccentrically in the field, as I suggested two years ago,* its centre being somewhat farther from the yoke than the centre of the polar cavity.

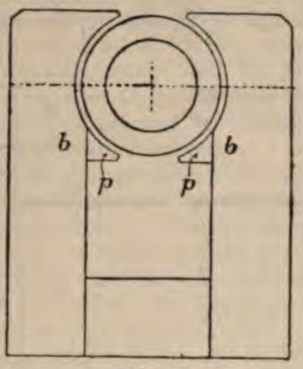


Fig. 9.

In some cases the magnets, after boring out, have been brought closer, so that the air gap increases gradually to the polar tips; but though the pull is reduced to some extent by these means, the device is not so efficacious as the one previously mentioned. I understand that in order to reduce heating this latter course had to be adopted in the machines built for the Bradford Corporation, the magnets in these being somewhat similar in shape to that shown in Fig. 4.

Electrically there is in drum armatures no want of balance due to an unsymmetrical field, as every convolution of the conductor encloses the whole of the lines of force passing through the armature core. The only result of a want of symmetry is that the position of the brushes on the commutator for a sparkless collection may become more marked, and the variation of current possible without readjustment of the brushes therefore less. But in cylinder-wound armatures not only is there a want of magnetic balance when the field is unsymmetrical, but from the fact that each convolution encloses only half the lines passing through the core there is a want of electrical balance, and it becomes, in consequence, doubly important to get a symmetrical induction, or the same number of lines through each half of the armature. Though the lines were unequally divided there might not be any appreciable difference in the E.M.F.'s generated in each half with the brushes diametrically opposite; but from the fact that a want of electrical balance requires rather more lead to be given to the brush farther from the yoke, it is possible that the E.M.F.'s in the two halves of the windings may be unequal, the result being a local current round the armature and consequent waste of power.

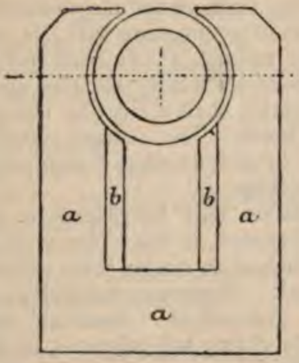


Fig. 10.

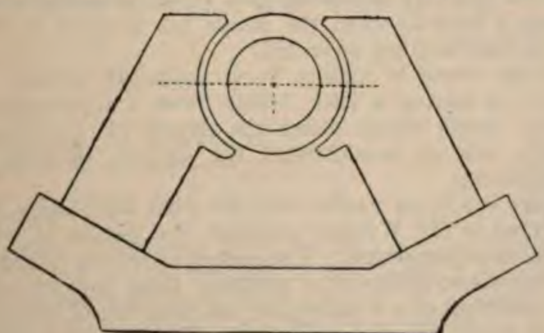


Fig. 11.

There are several methods of obtaining an approximately symmetrical field besides that already mentioned of placing the armature eccentrically in the cavity. What we have to do, if possible, is to make the path for the induction through the half of the cylinder core which is farther from the yoke of similar resistance to the path through the nearer half, so that a similar number of lines may flow through each. In the Phœnix dynamo we employ sometimes, with this object in view, the device shown in Fig. 7. Here the cast-iron magnet, instead of being rectangular in section, has the inside corners cut away, as shown in the section at *a*, the top corners at *b* being left on. In this way the magnetic resistance across the bottom path is increased, and the induction in the two halves of the armature made equal. Another plan is to shape the magnets as in Fig. 8, there being a faced joint at *a*. A plan adopted in several direct-driven ship sets we have just completed is shown in Fig. 9. The magnets are in this case of wrought iron, the limbs and top polar expansions being in one single forging, while the bottom polar expansions, *p*, are of cast iron. The magnetic resistance of the cast iron, combined with that of the joint at *b*, compensates for the diminished length of the induction path through the lower half of the armature. Another design by which the same end may be attained is shown in Fig. 10, where the magnet is partly of wrought iron, *a*, and of cast iron, *b*.

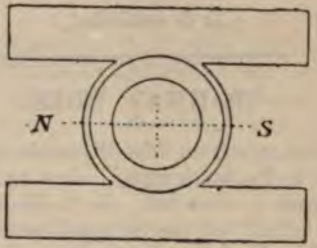


Fig. 12.

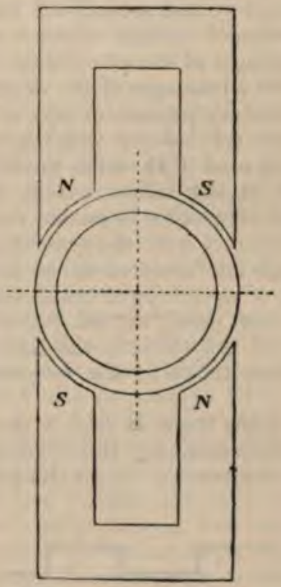


Fig. 13.

With a view to obtaining a more symmetrical field, some single-magnet machines have been shaped as in Fig. 11. Here, to attain the object, the magnetic circuit requires to be lengthened, the magnetising force required being correspondingly greater. In Fig. 12 is sketched a single-magnet machine, in which the field is quite symmetrical, although here the magnetic circuit has been made still longer.

It will be understood that it is possible to have an armature out of balance magnetically, while electrically it is perfectly balanced, as, for example, a drum armature in the misshapen field, Fig. 4. On the other hand, it is possible to have magnetic balance while electrically there is want of balance, as may be the case when a cylinder armature is placed in the four-pole field, Fig. 13.

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* The *Electrician*, vol. xx., p. 114, 1887.

When the armature core is carried round by spider arms, which fit into slots in the iron washers, it is important that the reduction of the core area due to these slots be as small as possible. Variation in the section causes magnetic kicks, or periodic fluctuations in the field during rotation.

(To be continued.)

TRAMWAY WORK.

The following report on Mr. Wynne's system of applying electricity to the working of urban tramways has been made by Messrs. J. Raworth, N. S. Russell, and W. M. Mordey, on behalf of the Brush Electrical Engineering Company, to Mr. Wynne:

We have lately had an opportunity of examining a scheme which bids fair to solve the problem of electric traction on tramcars without the use of open conduits or accumulators.

Mr. Frank Wynne, of 5, Westminster-chambers, is the inventor of the new system, in which power is transmitted from the engine to the car as directly as by rope traction, without the objectionable necessity of cutting a continuous slot in the roadway.

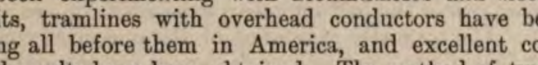
Mr. Wynne has been engaged in endeavouring to solve the problem of urban electric tramways for upwards of four years, his efforts have been watched with keen interest by engineers and electricians in England, and the skill and foresight with which he has approached the subject have met with general recognition.

While electricians and tramway companies in this country have been experimenting with accumulators and slotted conduits, tramlines with overhead conductors have been carrying all before them in America, and excellent commercial results have been obtained. The method of transmitting power to a tramcar by an overhead conductor, though well suited to new and rapidly-developing districts, is absolutely inapplicable to English and most continental cities, and no serious attempt has ever been made to introduce them in this country.

Mr. Wynne's new system secures all the advantages of an overhead conductor system without any of the constructive disadvantages of an open circuit.

Among the chief advantages of the overhead system are that it enables ordinary permanent way to be utilised without reconstruction for heavier weights, and it allows of existing cars being used with some modifications. These advantages hold to the fullest extent in Mr. Wynne's system, the object of which is to enable the electric current to be transmitted direct from the generating station to the car motors through an insulated cable laid underground, after the manner of electric light cables, with absolute safeguards against the possibility of including any of the ordinary traffic of the street in the electric circuit. The current used is that known as the low-tension continuous current.

In the centre of the track is laid a crenellated contact plate or rail in short sections; this contact plate or rail is not straight, but is formed to follow the junction line of the sets thus:

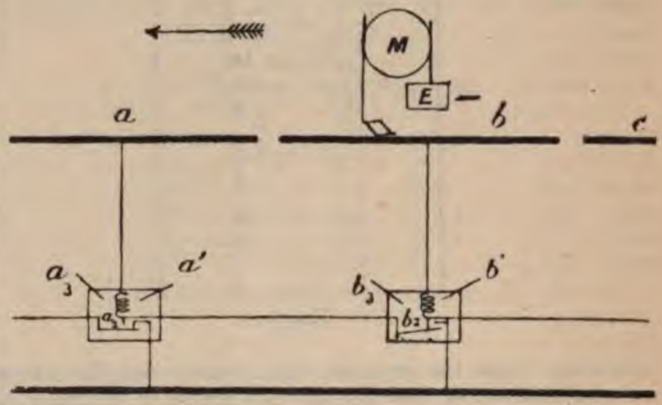


It is half an inch wide on the surface and about 4½in. deep, it offers no obstruction to carriages crossing the track, and affords a good foothold for horses.

Mr. Wynne has invented a remarkably simple device whereby the sections of the centre rail are successively put in connection with the main insulated conductor as the car passes over them, and are disconnected again as the car proceeds.

The only sections in connection with the main are those covered by the cars and its platforms; two sections are always in circuit, and a third section may be momentarily so connected as the contact brushes carried by the car pass over one of the separating spaces. The sections are necessarily short, and the inevitable leakage is therefore reduced to quite a negligible quantity.

The device for making contact with the sections of the central rail is shown in the following diagram:



a, b, c, d are four sections of the sectional contact rail, a^1, b^1, c^1, d^1, are electromagnets traversed successively by the current passing from the main conductor + to the car motor, M.

a^2, b^2, c^2, d^2 are armatures and contact makers, actuated severally by the electromagnets, a^1, b^1, c^1, d^1, and are severally contained in the contact-boxes a^3, b^3, c^3, d^3.

It will be noticed that as the car passes over section b, the current passing through the magnetic coil, b^1, not only closes the contact in connection with its own magnet, b^1, but also puts the magnet a^1 in circuit and parallel with b^1.

This arrangement effectually obviates sparking, and provides that one section shall always be charged in advance of the contact brush. The contact pieces assume their original position by gravity, thus disconnecting the sections as the cars leave them.

The contact-boxes may be placed in any convenient position, as, for instance, in the footway or kerbs, but their construction is such as to render them suitable for fixing in the tramway track. The boxes themselves are of cast iron or steel, with a grooved or "diamond" surface, and are constructed on the diving-bell principle, so that the enclosed air will absolutely debar water from rising into the interior.

It is obvious that it is an essential part of the scheme that the current should never be cut off entirely from the magnets, for under such circumstances they would break contact with the sectional rail, and the car could not proceed. Mr. Wynne has provided thoroughly practical devices both for maintaining the circuit and for remaking it in the event of accidental disturbance, as, for instance, by reason of the car leaving the rails.

Under ordinary circumstances a small percentage of the current is kept on when the motor has stopped, or when the car may be going down hill.

In the event of contact being accidently broken, the driver by moving a lever brings down a supplementary contact brush which closes the circuit of a single-cell battery, and so re-establishes the current through the contact-boxes.

There can be no doubt as to the great engineering skill displayed in Mr. Wynne's proposals, the details of which are eminently practical. The contact-boxes are numerous, but there is no difficulty in adapting them to work under the conditions of a tramline, and the mere fact of the necessity of their manufacture in large quantities will reduce their cost and tend to simplify their details. This tendency is well illustrated by Lancashire cotton mills, in which 40,000 spindles are often found working all the year round, with scarcely any repairs.

We are much impressed with Mr. Wynne's scheme, and consider that it is the only practical attempt that, up to the present, has been made to grapple with the real difficulties of urban electric traction.

Batteries are ruinous at present prices, overhead conductors inadmissible in English towns, and open conduits are an aggravation of all the evils attendant on the use of straight rails in crowded streets. Mr. Wynne's invention has none of these drawbacks. We do not think that his crenellated contact rail would be in any way objectionable in well-laid roads such as are usually found in London and the principal provincial towns.

On the question of capital cost and cost of power, we have carefully examined the accompanying estimates laid before us by Mr. Wynne, after comparing them with data derived from our own experience; and we are of opinion that they are formed on a good commercial basis, a sufficient margin having been allowed for extras which are inevitable in carrying out a new scheme.

The estimate of capital expenditure for applying this system to an existing tramway amounts, as shown, to £2,200 per mile of single track. This leaves out the items of real estate and buildings, which will be much less for a line worked by electricity than for one worked by horses, in which the area of ground and the buildings required for stables and granaries are very large.

Against this capital expenditure of £2,200 per mile (including, as it does, boilers, engines, and dynamos for twice the maximum power required at any one time) must be set the capital cost of horses and of horse-cars, amounting respectively to £1,500 and £500 per mile on the North Metropolitan Tramway, or altogether to a sum nearly equal to that for applying electricity.

The large figure of 7½ e.h.p. per car has been introduced with these estimates to cover a line with steep gradients, and so make the estimate of safe general application. American experience shows that this is an ample allowance for the not very marked effect of gradients in increasing the aggregate power required.

Estimate of Capital Cost.

Tramline, 4 miles in length, double track.
Generating station in centre, 2 miles from each end.
Average speed, 7 miles per hour.
Ten minutes' service.
Car speed, 2,000 yards apart.
Total cars in action at one time, 7.
Electric horse-power per car, 7½ = 5,600 watts.
Total e.h.p., 52½ = 40,000 watts.
Voltage at generating station, 250.
Maximum loss 15 per cent. = under 40 volts.
Amperes per car in middle of line, 20.
" " at ends " 25.
Main conductor tapers in half-mile lengths from generating station to termini.

The lengths and sizes of conductors are as follows :

2.	½-mile lengths	·195 square inches.
2.	" "	·150 " "
2.	" "	·103 " "
2.	" "	·053 " "

The most suitable cable for the purpose, having regard to the number of joints, will be Callender's bitumen insulated cable, which may be obtained at the following prices :

1 mile ·195	£300
1 " ·150	250
1 " ·103	160
1 " ·053	95
16 miles of junction wire at £35......................	560
Roadwork at 2s. 6d. per yard	880
Casing at 2s. 6d. per yard	880
Joiners' work..	500
Contact-boxes (every three yards), at 15s............	3,600
Crenellated rail, 33 tons per mile, at £6 per ton ...	1,584
Supervision and sundries, at £100 per mile	800
Generating station for 120 e.h.p., being double the maximum power required at any one time for working the line, and including a complete duplicate plant of boilers, engines, and dynamos, at £30 per e.h.p.	3,600
Eleven cars (four in reserve) complete with motor and fittings, at £400	4,400
Total..	£17,609

Say, £17,600 for the eight miles of single track, or £2,200 per mile.

Estimate of Cost of Power per Car-Mile Run.

It takes 1 h.p. hour to drive a tramcar one mile. (This agrees with the results of extensive working in America.)

The cost of this, including coal, oil, waste, water, engineers, firemen, and dynamo men, with depreciation at 7½ per cent. per annum on half the generating plant, amounts to 1½d.

FRANK WYNNE.

February 1st, 1890.

BARNSLEY.

The Barnsley Corporation have this session deposited with the Board of Trade an application for the grant of a provisional order, under the Electric Lighting Acts, 1882 and 1888. In furtherance of this decision, the Corporation has issued to contractors certain conditions to regulate their tenders, and a form of proposal to be filled up by those who desire to tender for the work. The conditions and form of proposal have been drawn up by Mr. J. Henry Taylor, Assoc.M.I.C.E., the borough water engineer. We subjoin the conditions :

These "conditions" and "form of proposal" are intended to be in conformity with the terms, clauses, and schedules of the said provisional order and with the said Acts, and particularly with section 11 of the Electric Lighting Act, 1882; but should there be any difference or disagreement between such "conditions" and "form of proposal" and the provisional order or the said Acts, the former must give way to the latter.

The term "corporation" shall mean the mayor, aldermen, and burgesses of the borough of Barnsley.

The terms "contractors" shall mean the companies or persons submitting the "proposal."

The term "the works" shall mean the site or sites, buildings, plant, apparatus, lamps, lampposts, lamp brackets, pipes, mains, wires, boxes, and appliances to be provided, and the operations to be conducted for the provision and supply of electricity, and the execution of the powers conferred upon the Corporation by the provisional order.

The term "the map" shall mean the copy of the street map of the borough of Barnsley, prepared by John Henry Taylor, a copy of which has been deposited with the Board of Trade, and a copy of which may be had upon application to the said John Henry Taylor.

The term "inner area" shall mean that portion of the borough of Barnsley which is shown upon the map and thereon coloured pink, and which is described in the first schedule of the draft provisional order.

The term "extension of inner area" shall mean such part or parts of the municipal borough of Barnsley as may be added to the inner area, in the manner described in section 6 of the draft provisional order.

The term "Board of Trade unit" shall mean the energy contained in a current of 1,000 amperes flowing under an E.M.F. of one volt during one hour.

The term "conditions" shall mean the explanations, information, and conditions written herein.

If their proposal be accepted, the contractors shall, within one calendar month after the date of the granting of the provisional order, enter into a contract with the Corporation to purchase a site or sites, to build a station or stations, to fix, erect, and establish a plant of the best, newest, and most approved kind for the generation, supply, and distribution of electricity, and to execute and maintain all other works necessary for purposes of illumination both for public and private purposes, and for working motors, engines, machines, and other similar apparatus, and generally to execute all the powers conferred upon the Corporation and the duties imposed upon them by the provisional order, and such site or sites shall be purchased, such buildings be erected, such plant established, and such supply and distribution be available for use for the whole of the inner area within two years of the date of the provisional order, and within any extension of inner area as shall be fixed by the Corporation, and within the whole of the municipal borough of Barnsley, within such periods as shall be agreed upon between the parties.

The contractors, if a company, shall deposit with the town clerk of Barnsley a copy of their prospectus, and a statement giving the date of their registration, the amount of capital authorised and subscribed, and if a private person or persons the names of at least three separate persons to whom reference may be made as to the engineering and financial ability of the contractors to carry out the contract.

The contractors shall describe the position and the area of the site or sites of the proposed station or stations at which electricity will be generated, and shall also submit therewith draft plans, sections, and elevations of the buildings proposed to be erected to form such station or stations; such plans, sections, and elevations may be drawn to any scale not less than 16ft. to 1in., and coloured to represent the materials of which the buildings will consist.

The contractors shall describe in detail in their proposal the system under which they intend to generate and supply electricity, whether the mains, leads, or wires are intended to be laid underground, or erected overhead, and the means they propose to adopt for the protection of the public from shock, fire, explosion, or other dangers which may arise from the execution and maintenance of the works.

The contractors shall describe in detail the boilers, engines, dynamos, lamps, lampposts, lamp brackets, shakles, insulators, pipes and other apparatus which they intend to provide and fix, together with drawings or printed illustrations of the same, and shall state the earliest date at which they will be able to have in operation from a permanent station and in a permanent manner a certain number of lamps of various candle-power in the streets and roads used by the public within the inner area. The contractors must state in their proposal the number of each of such lamps.

The contractors shall within one month of the date of the said contract to be entered into with the Corporation deposit or secure to the satisfaction of the Corporation the sum of £3,000 as a guarantee that they will carry out the works referred to in clause 5 of these conditions, and the compulsory works referred to in sections 18, 19, 20, 21, and 22 of the provisional order, and such sum shall remain secured or deposited for the period of two years, and be liable to forfeiture to the Corporation on the default of the contractors to carry out the contract to the satisfaction of the Corporation.

The contractors shall state the maximum and minimum charges, and a tabulated graduated scale of charges at which electricity will be supplied to the public, both at so much per Board of Trade unit, and per lamp or lamps of various descriptions and candle-powers, and also state the annual charge for a varying scale of hours at which the public lamps for the lighting of the streets, roads, market-places, courts, and passages will be supplied with electricity.

The contractors must describe in detail any meter or meters for the measurement of the electric current that they intend to use, and the charge or charges they intend to make for the same.

The highways and streets under the control of the Corporation, where required to be taken or broken up, or otherwise disturbed for the purposes of carrying out the contract, shall be so taken or broken up or otherwise disturbed and made good by men in the direct employment of the Corporation, and the cost shall be paid to the Corporation by the contractors within one month of the date of the account sent in to the contractors.

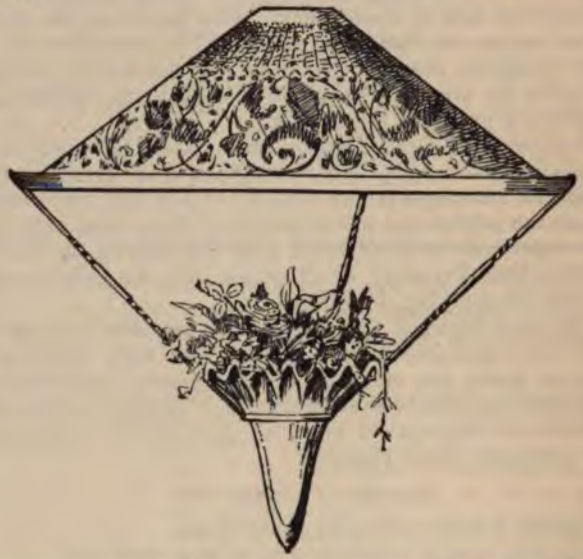
The contractors shall state the terms upon which and the dates at which they will convey or sell to the Corporation the whole of the works which they have provided or executed and maintained for the generation, production, supply, and distribution of electricity within the municipal borough of Barnsley. The dates to be 7, 14, 21, 28, 35, or 42 years from the commencement of the contract.

In case of the failure or inability of the contractors to carry out the terms of the contract, the contractors shall pay the damages sustained by the Corporation by such failure or inability. The contractors shall not transfer their contract to any other contractors or persons; and the Corporation shall be empowered to enter upon and take possession of the works, and take any other course they may think fit, without regard to the contract entered into.

The contractors shall comply with all the requirements and provisions of the provisional order and the said Acts as to notices, descriptions, maps, plans, testing, meters, supply, prices, and any other requirements contained therein.

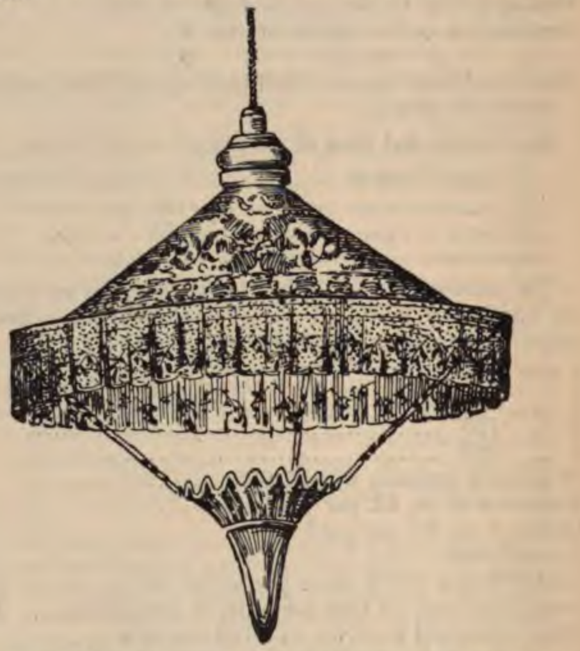
A NEW COMBINATION FITTING.

Manufacturers of electrical fittings—such as brackets, pendants, etc.—are feeling very hopeful in the prospect of a large and increasing business in the future by reason of the great demand that must inevitably arise for these articles, if even one-half of the projected central stations for supplying the electric light be safely started in full working order within the next year or two.



Consequently a large variety of patterns and shapes are continually being introduced to the notice of traders in electric fittings; some have a degree of novelty about them, others are merely adaptations or *rechauffés* of designs already in use.

The illustrations appended herewith, however, are descriptive of what is certainly a new combination for pendants, though the same idea has been for some time employed in the case of brackets.



The fitting therein shown has been brought out by Messrs. Wheatley Kirk, Price, and Goulty, of 39, Queen-street, E.C., the special name of "E.P. Combination Fitting" being given to it. An ordinary opal or flint-glass conical shade (etched or decorated in a variety of designs) is provided with a slightly turned-up rim, from which are hung three brass arms fixed to a brass ring underneath to carry a small glass flower or bouquet-holder.

The brass arms are also provided at the top each with another hook pointing outwards (not shown in the sketch). On these hooks is placed a plain wire ring, threaded through lace or silk fringe.

This fitting—which is also constructed in wrought iron, copper, or any other material lending itself to artistic treatment—presents a very neat appearance when complete ; and as it can be turned out at a moderate cost, it should prove serviceable for many purposes—*e.g.*, to suspend over dining-tables, or for use in drawing-rooms and boudoirs.

It is easily fitted up, and as easily turned into an ordinary plain fitting when so desired.

The makers, we understand, have both registered the various designs and patented the combination as applied to a pendant.

SUPPLY OF ELECTRICITY.

ACTION OF LOCAL AUTHORITIES AND BOARD OF TRADE.

At the weekly meeting of the Balloon Society of Great Britain, held on Friday evening last at St. James's Hall, W., Mr. W. H. Le Fevre, C.E. (president), in the chair, Mr. George Offor, managing director of the Electric Installation and Maintenance Company, Limited, delivered a lecture on the above subject.

The Lecturer referred briefly to the advantages incidental to the use of electricity for light, traction, and power for small machinery, and assumed that the real points of interest were the systems of supply, the probable cost, the safety of the new power, and the means by which it could be obtained. He pointed out the relative advantages of the systems in vogue—viz., the high-pressure alternating current of 10,000 volts, as proposed to be supplied from the large works at Deptford of the London Electric Supply Company ; the same system with a similar current of 1,000 to 2,000 volts, as supplied by the Metropolitan and House-to-House Companies ; the direct supply by low-pressure current direct from the dynamo machine, as supplied by the St. James's and Pall Mall Electric Light Company ; the low-pressure current, with the partial use of storage batteries, which is adopted by the Kensington and Knightsbridge Company ; and finally the system of the Chelsea Electricity Supply Company, which consists of a single generating station supplying storage batteries placed in various parts of the district, each accumulator station supplying an area of about half a mile entirely from storage. The lecturer gave details of the successful working of this latter system, and quoted Major Marindin's opinion that he considered it as the best. The question of cost was illustrated by the actual experience of the Chelsea Company, the chairman, Mr. J. Irving Courtenay, having stated at the general meeting on Wednesday last that it only amounted to 2⅜d. per Board of Trade unit in December, when 93 houses only were supplied with a total of 8,730 lamps installed, the cost having fallen from 4¼d. in October, when the number of lights were a little over 3,000. Mr. Offor also referred to the prices charged to consumers by the Bradford Corporation—viz., 5d. per unit—and that proposed to be charged by the Vestry of St. Pancras—viz., 4¼d.—which they estimated would yield a profit of 1d. per unit.

On the subject of danger the lecturer contended that electricity was by far the safest method of illuminating, and quoted from the New York Board of Coroners the statistics of fatal accidents last year, from which it appeared that there were 21 deaths directly attributable to gas and nine to electricity, and of the latter only two being to private citizens, the remainder through carelessness of workmen.

The lecturer next dealt with the difficulties in the way of companies formed for the supply of electricity. He pointed out the onerous clauses in the Electric Lighting Act of 1882 relative to the right of purchase by local authorities and the subsequent amendment in 1888, which extended the time for compulsory sale of the undertakings from 21 to 42 years, which had given an impetus to the new industry by bringing forward capital ; but, on the other hand, a reactionary alteration had been made in 1888 in the Act of 1882, which excluded local authorities from interference with the grant of provisional orders by allowing them, under the amended Act, to give or withhold consent. It is true, the lecturer explained, that the Board of Trade can dispense with such consent if they consider the refusal unjustifiable, but everything depends upon the course they will adopt ; meanwhile, the change in the law was considered by the lecturer as a step in the wrong direction, local authorities, in the majority of cases, refusing their consent, and throwing the onus upon the Board of Trade.

The lecturer pointed out that in many cases the opposition of local authorities was purely obstructive, but in others they used their power to try and contract themselves out of the purchasing clause of the Act, by offering their assent to the order on condition that the period was reduced and proposing to pay a premium for this right. More than 40 local authorities had applied for provisional orders, but so far as could be ascertained very few intended to carry them out themselves. One in particular was referred to by the lecturer, as having advertised for companies to undertake the provision of electricity at their own risk, with special terms to the Corporation for being allowed to do so. In the case of a few local authorities there was a bona fide intention to supply electricity under their order, and he instanced Brighton, Hove, and Bradford, the latter having already commenced business on a large scale, with such an increasing demand that an extension of their electric lighting plant was already agreed upon.

At the close of the lecture Mr. W. R. Merritt moved, and Captain Wilson seconded, the following resolution : "That this meeting urges the Board of Trade to protect the interests of companies prepared to supply electricity from the opposition of local authorities who are unable to prove to the satisfaction of the Board of Trade that their opposition is justified by the special circumstances of the case."

After an animated discussion, in which Mr. T. Cornish, M.E., Mr. J. Wright, F.R.S., Major Leslie, Mr. Brownejohn, and others took part, the resolution was put to the meeting and carried.

PHYSICAL SOCIETY.—Feb. 21.

Prof. G. Carey-Foster, F.R.S., Past-President, in the chair.

Mr. S. Evershed was elected a member of the society. The following communications were read :

"On a Carbon Deposit in a Blake Telephone Transmitter." By Mr. F. B. Hawes. The author exhibited photographs of the interior portions of the transmitter on which the deposit had taken place. These portions consist of a metal diaphragm and a highly-polished carbon button, and a platinum contact-piece carried by a German silver spring placed between them. The diaphragm presented a mottled appearance, due to the deposit, but the part which had been behind the German silver spring seemed comparatively clean. The deposits on the carbon button and G.S. spring were much less dense than that on the exposed parts of the diaphragm, and the space near the point of contact between the platinum and carbon was free from deposit. The deposit was fairly adherent, considerable rubbing being necessary to remove it, and on examination under the microscope particles of copper and metallic crystals could be seen. The author believes the deposit due to some kind of bombardment of carbon particles, but was unable to say why it should occur, or why the varnished diaphragm should receive the greater deposit, although it was further from the carbon than the German silver spring. **Mr. C. V. Boys** said the photographs reminded him of a phenomenon he observed some time ago on a glass sheet, against which one terminal of a dry pile had been resting for some weeks. Just as on the carbon button, the glass near the point of contact was clean, and had a comet-shaped deposit formed around it. He could offer no explanation of the appearance.

"The Geometrical Construction of Direct Reading Scales for Reflecting Galvanometers." By Mr. A. P. Trotter. In a recent paper "On Galvanometers," by Prof. W. E. Ayrton, F.R.S., T. Mather, and Dr. W. E. Sumpner, read before the society, the opinion was expressed that proportionality of scale reading to current was very desirable, and the present paper shows how to bend a scale of equal divisions so as to give the required proportionality. Suppose the currents required to produce several deflections have been experimentally determined. A full-size plan of the scale is then drawn, and radial lines from the points on the scale at which the observations were taken are drawn towards the centre of the mirror. Let these radii be numbered 0, 1, 2, 3, etc., commencing from zero azimuth. According to the procedure recommended, distances proportional to the several current strengths are marked off along the edge of a strip of paper, a few inches being left over at each end. Call the marks a, b, c, d, etc., a being the zero point. Two points on the radii, 0, 1, and equidistant from the mirror, are now found such that the distance between them is equal to that between a and b on the strip, and the points marked by fine needles stuck in the board. The zero end of the strip is now fixed so that the marks a and b lie against the needles and the strip is swept round until the mark c coincides with the radius 2, where also a needle is placed. Repeating the process gives a series of points which on being joined form part of a polygon. A line can then be drawn between the inscribed and circumscribing curves, which has the same length as the sum of the straight lines, and this is the curve to which the original scale may be bent so as to give proportional readings. Diagrams showing such curves constructed from the calibrations of instruments given in the paper above referred to accompany the paper. The author showed that a family of curves may be drawn, each of which satisfies the required condition. Of the two limiting curves one is tangential to the usual scale line at zero azimuth, and the other passes through the vertical axis of the mirror. The flattest of the various curves is generally the most convenient. **Mr. J. Swinburne** asked whether good definition could be obtained when such curved scales not equidistant from the mirror were used, and also whether it was not easier to divide a flat scale unequally so that the readings are proportional to the current. **Mr. Trotter,** in reply, said Dr. Sumpner thought there would be no difficulty as regards definition with the flat curves shown. He (Mr. Trotter) also added that a curved scale might be advantageous in reading the deflections from one side of a table, as the more distant part of the scale could be more nearly perpendicular to the line of sight. For such an arrangement, however, a parallel beam of light would be required.

"A Parallel Motion Suitable for Recording Instruments." By Mr. A. P. Trotter. This is a modification of Watt's parallel motion in which the two fixed centres are on the same side of the line described by the "parallel point." The arrangement consists of two vibrator arms, one of which is twice the length of the other and whose outer ends are jointed respectively to the middle and end of a short lever; the free end of the latter describes an approximate straight line. The motion was arrived at by considering the curve traced out by a point on the radius of a circle, such that its distance from the circumference measured towards the centre is equal to the radial intercept between the circle and a tangent line. The equation to the curve is $r = 2 - \sec. \theta$ (conchoid of Nicomedes) and the radius of the osculating circle at the point where the intercept is zero is given as half that of the initial circle. This osculating circle, the author finds, practically coincides with the curve over a considerable angle (40deg.) and hence may replace this part of the curve, hence the motion. The author thinks the motion will be useful for recording barometers, ammeters, and voltmeters, as it is more compact than that of Watt, and needs no fixed point beyond the straight path.

Owing to the absence of Prof. S. P. Thompson his paper "On Bertrand's Refractometer" was not read.

COMPANIES' MEETINGS.

NOTTING HILL ELECTRIC LIGHTING COMPANY, LIMITED.

A general meeting of this Company took place on Tuesday at the offices, 9, Austin-friars, E.C.

Mr. William Crookes, F.R.S., the chairman, presided, and explained that the result of the recent application to the public had been a subscription of about £70,000, which was sufficient to comply with the terms of the Act. This had enabled the Board to apply for a special settlement and quotation on the Stock Exchange. Freehold land had been purchased for a central station in an excellent position, and contracts had been entered into for the necessary machinery and plant. A large portion of the Company's area consisted of highly-rented houses, and by the end of the year they will have covered the compulsory area in the northern portion of the district with a network of mains, and it is expected that many houses will be electrically lighted before the dark days of autumn set in. Experience has shown that between 30 and 35 houses paid the expenses of working, while the first 200 houses brought in a profit of £3,000 a year, and the first 400 houses £7,000 a year profit. Their own Company had more than 4,000 houses in the district, and the Board therefore looked forward to a most successful future for the concern.

At a special meeting which followed, a formal alteration was made in the articles by desire of the Secretary of the Stock Exchange.

NEW COMPANIES REGISTERED.

Poole and White, Limited.—Registered by Saltwell and Tryon, 1, Stone-buildings, Lincoln's-inn-fields, W.C., with a capital of £20,000 in £5 shares. Object: to carry on the business of electric lighting, and for such purpose to acquire the business of Messrs. Poole and White. The first subscribers are:

	Shares.
T. G. Poole, 58, Bread-street, E.C.	10
W. White, 58, Bread-street, E.C.	10
E. F. Smith, J.P., 34, Avenue-road, N.W.	50
J. Tryon, Stone-buildings, Lincoln's-inn, W.C.	40
A. Moss, 28, Lincoln's Inn-fields	40
N. Heaver, 8, St. James's-square, Notting Hill	1
F. H. Snow, 31, Oakhill-road, S.W.	1

There shall not be less than three nor more than five Directors. The first are T. G. Poole, W. White, and J. Tyron. Qualification, other than T. G. Poole and W. White, 50 shares. Remuneration, £250, divisible.

PROVISIONAL PATENTS, 1890.

FEBRUARY 17.

2527. **Improved method for the regulation of the carbons in electric arc lamps by the expansion and contraction of metallic wires.** Oliver Cornwell, 117, Ditchling Rise, London-road, Brighton, Sussex.

FEBRUARY 18.

2578. **A "Pocket electrical transmitting and receiving instrument."** J. R. Fraser, Preston, Lancashire.

2621. **Improvements in electrically-driven fans.** Henry Garwood Watel, 28, Southampton-buildings, London. (Complete specification.)

2653. **Improvements in electric meters.** Sebastian Ziani de Ferranti, 24, Southampton-buildings, London.

2654. **Improvements in the manufacture of electric cables.** John Edward Kingsbury, 24, Southampton-buildings, London. (The Western Electric Company, United States.)

2655. **Improvements in insulating electric wires.** John Edward Kingsbury, 24, Southampton-buildings, London. (The Western Electric Company, United States.)

FEBRUARY 19.

2659. **Improvements in electric arc lamps for use in search light projectors and other purposes.** The Hon. Charles Algernon Parsons, 13, Temple-street, Birmingham.

2660. **Improvements in lamp holders, or socket for incandescence electric lamps.** Ronald Augustus Scott, The Elms, Acton Hill, London.

2687. **The utilization of a waste product for the means of producing electricity.** Alfred William Armstrong, 132, Southwark-street, London.

2688. **Improvements in or connected with electric wire running and appliances therefor.** Alfred William Armstrong, 132, Southwark-street, London.

2716. **Improvements in the method of mounting by anti-friction gear electrical or other motors upon tramcars or other locomotives.** William John Brewer, 1, Queen Victoria-street, London.

FEBRUARY 20.

2759. **Improvements in the lighting of railway trains by electricity.** Illius Augustus Timmis, 2, Great George-street, Westminster.

FEBRUARY 21.

2797. **Improvements in coding and transmitting telegrams and secret messages.** Samuel Joseph Mackie, 27, Chancery-lane, Middlesex.

2819. **An improved electrolytic solution for galvanic batteries.** Carl Lütcke, jun., 191, Fleet-street, London. (Complete specification).

2825. **Improvements in bases, covers, and fixings for electrical safety fuses, switches, and the like.** William White, 28, Southampton-buildings, London. (Complete specification.)

2838. **An automatic or coin-freed apparatus or attachment for use in connection with telephones.** Frederick Richard Simms, 4, South-street, Finsbury, London.

2843. **A new and improved telephonic receiver.** Henry Charles Braun and Arthur Ford Lloyd, 1, Gate-street, Lincoln's Inn, London.

2844. **Improvements in the construction of continuous current dynamo armatures.** Llewelyn Birchall Atkinson, 1, Queen Victoria-street, London. (Complete specification.)

2845. **Improvements in secondary batteries.** Edward Thacker Mackrill, 1, Queen Victoria-street, London.

FEBRUARY 22.

2876. **Improvements in safety apparatus and devices for preventing danger from high tension electric currents.** Henry Edmond Walter, 23, Southampton-buildings, Middlesex.

SPECIFICATIONS PUBLISHED.

1885.

12984. **Working metals, &c., by electric currents.** De Benardos and another. (Second edition). 1s. 3d.

1889.

5291. **Current motors.** Zipernowsky and others. 8d.

5423. **Conduits for electric conductors.** King. 6d.

11927. **Covering electrical conductors.** Pitt (Atherton). 8d. (Amended specification).

CITY NOTES.

Brazilian Submarine Telegraph Company.—The receipts for the week ended February 21 amounted to £4,637.

Western and Brazilian Telegraph Company, Limited.—The receipts for the week ended February 21, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,526.

Telegraph Construction and Maintenance Company, Limited. This Company state that the accounts for the year show a net profit of £83,746, after charging the interest on the debentures. To this sum must be added £43,377 brought forward, making a total of £127,123. The Directors propose a dividend of £1. 16s. per share, being at the rate of 15 per cent., and making, with the amount already paid, a total dividend for the year of £2. 8s. per share, or 20 per cent., tax free, leaving £37,483 to be carried forward.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday.
Anglo-American Brush	—	2⅝
— Pref.	—	1⅞
India Rubber, Gutta Percha & Telegraph Co.	10	18⅞
House-to-House	4½	5
Metropolitan Electric Supply	—	4½
London Electric Supply	5	3½
Swan United	3½	5½
Telegraph Construction	12	45
— 6%, 1889	100	105
National Telephone	5	5¼

NOTES.

Breslau.—A second telephone wire is being considered between Berlin and Breslau to serve the industrial district around Ratibor.

Co-operative Telephones.—A movement is on foot to institute a co-operative system of telephones in Glasgow similar to that already proposed in Manchester.

Westminster.—The Westminster Electric Supply Company met on Wednesday at 4, Victoria-mansions, and sanctioned the proposed changes in the articles of association. The proceedings were formal.

Institute of Chemistry.—At the anniversary meeting of the Institute of Chemistry of Great Britain and Ireland, held at Burlington House, on Saturday, Dr. James Bell, C.B., F.R.S., was re-elected president

Scotland to America.—A new station has been opened to the public by the Direct United States Cable Company, at 40, Hope-street, Glasgow, for the acceptance, transmission, and delivery of American telegrams.

Society of Arts.—Those who are interested in the "Chemin de Fer Glessant," or sliding railway, may be glad to attend the paper on this subject, at the Society of Arts, by Sir Douglas Galton, Sir Frederick Bramwell in the chair.

Institution.—At the meeting of the Institution next Thursday, the 13th inst., the adjourned conjoint discussion will be resumed of Mr. Swinburne's paper on "Armature Reactions," and Mr. Esson's paper on "Dynamo and Motor Design."

Lecture on Electricity.—A lecture was given in the Town Hall, Uttoxeter, on the 21st ult., in connection with the Young Men's Association, by Mr. G. Fletcher, A.I.E.E., of Derby on "Electricity in our Homes," which was received with great interest.

Moulded Mica.—Insulators made of moulded mica for commutator brush holders, wire insulators, etc., are made for electrical purposes by the Gould and Watson Company, Hartford-street, Boston, U.S., and are used by the Sprague and Thomson-Houston companies.

Switches.—Messrs. Poole and White have introduced a very neat little one or two light switch with porcelain base which seems to be a desirable addition to available fittings —some 20,000 have already been ordered—in itself a good indication of the way in which house lighting is progressing.

Provisional Orders.—There have been 161 applications for provisional orders this year, as against 17 last year. The capital now intended to be raised for electric lighting purposes is £9,242,828, or an advance of £8,244,828 beyond the sum proposed to be raised last year.

Spiral Filaments.—A form of spiral filament for incandescent lamps is being introduced by the firm of Laughans and Co., in Berlin. A metal pillar rises almost to the top of the lamp, and around this the filament curls in seven spirals, giving a compact centre for a lengthy filament.

Cutting and Ironing.—A striking instance of the usefulness of electricity in all departments is that reported from Minneapolis, where a motor not only runs the sewing machines in an overalls factory, but does all the cutting, and more than this, the current warms the irons that do the pressing of the goods.

Cologne.—A central station is to be established at Cologne, and a sum of 1,850,000 marks has been voted. The price has been fixed at 1d. per 100 watt-hours. The committee of the gas and water service has been directed to carry out this central installation, which is to be on the alternating-current system.

Balloon Society.—The council of the Balloon Society of Great Britain having determined to allot one evening a month to lectures and discussions on electrical science, persons desirous of reading papers or attending the meetings are requested to communicate with the secretary, 26, Budge-row, Cannon-street, City.

New Meter.—The new meter to which we alluded some months ago invented by Mr. Reckenzaun has we hear been perfected, and promises exceedingly well. It is exactly proportional for highest or lowest currents, is worked with the current itself, and being very simple in its parts, can be easily produced.

A Cable to New Caledonia.—Efforts are being made to arrange for the establishment of cable communication between Australia and New Caledonia. An officer of the French Navy is said to have been deputed by the Government of New Caledonia to try to form a syndicate of Sydney and Melbourne capitalists to take up this matter and the construction of a dock at Noumea.

Port Said.—By a contract dated December 31, 1889, the Egyptian Minister of Works has authorised M. Sigmund Fahn to establish, at his own risk, telephonic communication in the town of Port Said for a period of 15 years, with right of purchase by the Government after the tenth year. This concession does not include the privilege of monopoly.

Pulleys.—The pulleys manufactured by Mr. Tomlinson-Walker, engineer, Victoria Iron Works, York, have been selected by the committee of the Edinburgh Electrical Exhibition for driving the dynamos. Mr. Tomlinson-Walker has recently issued a catalogue of his patent pulleys and shafting, with rules for calculating speeds and sizes and other useful notes.

Popp System in Germany.—The work on the electric distribution of power on Popp's system in Berlin has already commenced. All special material will be supplied from France, and M. Popp is intending to give French houses at least a third of the contracts for laying mains, and the men who have to make the special apparatus will also be Frenchmen with a special knowledge of the work.

Parisian Electricians.—The employés of the Continental Edison Company are shortly to receive uniforms, with indication of their grade. A whole army of electricians may be, therefore, expected shortly, each distinguished by the colour of their caps and the amount of gold lace, indicating partisanship with the Edison, Popp, and Rothschild Companies, as well as that of the municipal electric service.

Fires caused by Electric Wires.—Two more serious fires are announced by Reuters telegrams as having been caused by electric wires. One occurred at a brewery at Elizabeth, New Jersey, the damage being estimated at 25,000dols. The other broke out in a dwelling-house at Schenectady, New York, and the owner was suffocated on returning to his burning home in the hope of saving some of his property.

Overhead Wires and Subways.—At the meeting of the Islington Vestry a letter was read from the Kensington Vestry asking Islington to co-operate with them in petitioning against the Bill giving powers to the County Council to deal with overhead wires and construction of street subways, as such powers should be vested in the District Boards of the metropolis. The matter was referred to the Highways Committee.

Newcastle.—The Newcastle Electric Lighting Committee have had an offer from one of the electric lighting companies to light the public lamps at the Cattle Market and the Central Station with electricity, at the same price as gas, the lamps being now equal respectively to 252 and 192 candles. The electric lamps will be equal to 1,500 candles. The committee have notified to the gas company that they intend to experiment with these two lamps.

Paris Meter Competition.—It is understood, announces the *Bulletin Internationale de l'Electricité*, that a prize of 1,000f. will be given in the electric meter competition at Paris to the excellent apparatus, as yet little known, of M. Jacquemier, and a bright future for this meter is expected. M. Danzer also states that it is intended to award a prize of 2,000f. for the meter of Dr. Aron, of Berlin, a meter which is already well known in England and giving admirable results.

Compound Brake for Tramcars.—A swift acting brake for tramcars and railways has been introduced in Germany by Mr. Albrecht, of Kolberg, which may be found useful for electric cars. A sliding brake is placed between both pairs of wheels and not only acts on all four wheels, but also on the rails. Hardened steel clutches grip the rails and prevent the sliding of the cars. A tramcar going at full speed down a steep street can be brought to an instantaneous standstill.

Electric Fittings.—We find on a visit to the General Electric Company that the general rush for electric installations is affecting them and making business very brisk. Their works at Salford are already splendidly equipped with automatic machines, making it one of the largest premises for the manufacture of electric fittings in the North, and they are now adding to this. They have just taken on more workmen, electric fitters for switchmaking, etc., and are looking for more.

Electricity in India.—The Chudderghauts Municipality, the *Indian Engineer* has heard, have received a proposal from the representative of Messrs. Siemens Bros., London, to light the whole of the streets within the municipal limits for a yearly payment of 11,000 rupees. The firm offers to put up 13 lamps for every 20 kerosene lamps at present in use. If the terms are accepted the Municipality would effect a saving of some 4,000 rupees a year, besides having the streets much better lighted.

Alternate Current Motors.—We believe we are right in saying that some important developments in alternate-current motors may be looked for, of which the Patent Office will bear record. The difficulty now encountered has been that the greater the power given out the more is the efficiency lowered, because of the call on the current for retardation of magnetisation. The new development will partake of the nature of back compound winding to obviate this loss of efficiency in high powers.

Agricultural Hall.—An international exhibition of machinery, manufactures, appliances, and inventions incidental to engineers, electricians, builders, and ironmongers is to be held in the Royal Agricultural Hall, Islington, from March 17th to 29th, 1890. The Midland Railway Company has arranged excursions from the principal large towns in the northern and midland counties. The present offices of the exhibition are at 43, New Oxford-street, W.C., and persons interested may obtain tickets by applying to this address.

Institution Scholarship.—At last Thursday's proceedings of the Institution of Electrical Engineers, the announcement was made by the President that Sir D. Salomons has made the munificent offer of £1,000 to found a scholarship of £35 per annum to be held for three years, and to be entirely under the control and at the disposal of the Institution. The council have gratefully accepted the offer, and have appointed a committee to consult with Sir David Salomons and settle all the details in connection with the scholarship.

Storage Cars in the States.—The Council Committee at Rochester, N.Y., appointed to confer with the Rochester City and Brighton Railway Company regarding the substitution of electric for horse traction, has recommended that permission be given the company to adopt the overhead system. The pressure is not to exceed 500 volts. The storage battery system may be adopted later if desired. At Philadelphia, a storage battery car owned by the McLoughlin Electric Company is being tried on the Germantown branch of the People's line.

Underground Telephone Wires.—The great increase of telephone wires in Germany has occasioned a great deal of trouble with the wires, owing to the constantly growing reluctance of householders to give wayleaves. The telephone authorities are therefore now putting the wires underground. In Berlin a large number of wires are being run as cables and drawn through gas-pipes, while in Hamburg they are run in cast-iron troughs. The necessity to put wires underground in cities is continually growing, and is the subject of careful experiment upon the Continent.

Gas-Electrics.—Mr. Hutchinson's presidential address at Manchester encouraged the gas companies to be of good cheer, as they would be able to supply electricity more economically than the electric light companies, by utilising the heat from the furnaces now necessarily wasted—that in fact, electricity would prove a boon to gas companies—which, in the right hands, it undoubtedly might be made to be. After thus ranging himself upon our side he curiously enough incongruously finished by finding fault with electricity on account of injury to eyes, danger from fires, and, sooth to say, "horrid smells."

Brighton.—A very excited special meeting was held by the Brighton Town Council on Monday afternoon in connection with the question of lighting the town by electricity, the Corporation having resolved upon undertaking to supply the electric light to the south-western portion as a first instalment. The discussion took place upon the purchase of a site by the Lighting Committee for a distributing station, and numerously-signed petitions against the general scheme were presented from each ward. An adjournment of the debate for two months was moved, but the report of the committee was adopted after a long sitting.

Plymouth.—At the meeting of the Devonport County Borough Council, a report was read from the Highways and Streets Committee on the subject of the Plymouth, Devonport, East Stonehouse, and Compton Gifford electric lighting provisional order, stating the company had abandoned the idea of supplying any place with electricity other than Plymouth, and it was agreed to offer no opposition. Mr. W. H. Clarke was sorry at the matter having fallen through and that they were not to have the electric light at Devonport, as they had been in darkness long enough. The Mayor said they had all to gain by waiting in this matter, and the report was adopted.

Weymersch Battery.—It may be interesting to mention in connection with the Weymersch battery that the inventor, M. Weymersch, is not a German, as his name would seem to indicate, but a Frenchman, at one time we believe (like Nikola Tesla) destined for the priesthood, but by bent of nature and the development of scientific opportunities, devoting himself to electricity. M. Weymersch was for some time a chemist in France, and afterwards worked with M. Paul Jablochkoff in Paris. He has been assiduously working and experimenting with his battery for the past four or five years, and for the last sixteen months has been devoting himself to the perfection of the details at the works of the Silvertown Company.

Aron's Meter.—The favour in which Dr. Aron's meter is regarded is well shown by the greatly increasing number now being supplied. While in the first year they were introduced there were only 26 sold, and the second year showed only 54, the third shows 354 meters, and during the two months in this year alone over 300 have been supplied in England and as many more are on order. It is probable that at this rate some 1,500 will be supplied during this year. There are over 6,000 in use in England and on the Continent. The advantage of reading either direct or alternating is a great point in their favour, and they are used by many central stations, among which, we believe, are the Kensington Court, the St. James, the Cadogan, and the Chelsea electric supply stations.

Bridlington Contract Postponed.—At a meeting of the Local Board, held on Tuesday, Dr. Redman, the chairman of the Building and Lighting Committee, read a telegram which he had received from Messrs. Laing, Wharton, and Down, to the effect that as their tender for lighting the town by electricity had not been accepted at the last meeting of the Board, they had entered into other contracts elsewhere, and could not now undertake to put down the plant in the requisite time. It was therefore resolved that the tender of the Bridlington Gas Light Company be accepted for the next 12 months. With a view of furthering the ultimate adoption of the electric light, a committee was appointed to make a survey and report on the number and quality of the lights required.

Cellulose for Storage Batteries.—Cellulose fibre is used by the Pumpelly Storage Battery Company, Chicago, as a packing material between plates, and is said to give excellent results. This cellulose is made from wood pulp by a patented process, and used by paper manufacturers to mix with the rag pulp in the making of the finest quality of white paper. It is perfectly inert, and unchangeable in any acid; also a non-conductor, thus adding no more to the conductivity between the pole plates of the battery than is given to the electrolyte by the use of a certain per cent. of sulphuric acid. It prevents all splashing in the cell, checks evaporation for a long time, retains the specific gravity of the electrolyte even throughout the entire cell, and does not, as one would suppose, increase the internal resistance. These advantages are marked when used for traction work.

Electricity Direct from Coal.—Although we do not hear very much about the discovery of practical methods of generating electricity direct from coal without the intervention of dynamos and moving machinery, it must not be supposed that workers in the field are idle. It will be remembered by scientists that a silver medal was awarded at the time of the Inventions Exhibition for an apparatus of this sort, in which an electrical pressure was obtained from incandescent hydrogen occluded through platinum tubes at a very high temperature. These experiments are being continued, and the results seem to justify the idea—though in what time it is hardly possible to say—that a practical solution will be arrived at. Prof. Perry has already publicly announced his belief that the experiments will result in a practical method, and these are not the only workers in this extended field.

Paris Electrical Laboratory.—The surplus of the Paris Exhibition of 1881, amounting to 331,405f., has been applied to the establishment of an electrical laboratory under the auspices of the Société Internationale des Electriciens. For some time the Société have for the sake of economy accepted the kind offer of MM. Menier and established their laboratory at the works of this firm in the Rue Grenelle. The Paris Municipal Council have just conceded to the Société a site for the better establishment and development of this laboratory, free of all charge, save a nominal one of one franc a year, for the period of 60 years, on the conditions that after this period the whole building to be erected shall become, with its permanent fixtures, the property of the Council, and also that the société shall reserve gratuitously two scholarships for electrical students designated by the Council for practical course in the laboratory, and that one municipal councillor shall be on the committee of the laboratory.

Parliamentary.—In the House of Commons on Monday, Mr. Causton asked the President of the Board of Trade whether the Board had determined, without enquiry into the circumstances of the case, not to proceed with any applications for provisional orders to supply electricity if the local authorities refused their consent, and thus to ignore the power vested in them by section 1 of the Electric Lighting Act, 1888, which provided for dispensing with such consent. Sir M. Hicks-Beach said such determination has been arrived at. In view of the sessional orders of Parliament, the Board of Trade informed promoters of provisional orders that they could not proceed with applications unless the consent of the local authority was produced by February 25. Where, however, as has already been the case, the promoters request the Board of Trade to dispense with such consent, their applications will be carefully considered, and if there appear to be exceptional circumstances connected with the refusal of the local authority, an enquiry will be held.

Compressed Wrought Shafting.—Special compressed polished shafting of a high quality not requiring turning is introduced in Germany by Messrs. Reimbold, of Mettmann, whose products are exclusively sold by Mr. Ed. Dunkelberg, of Berlin and Leipsic. These shafts are produced to exact diameter (guaranteed $\frac{1}{500}$in.), perfectly round and straight. They are made of pure soft Siemens-Martins steel 20 to 25 per cent. carbon, admitting of being welded and tempered. They have 50 per cent. greater tenacity than ordinary shafts, so that with seven-tenths the diameter and half the weight will give equal strength. They are made sizes $\frac{1}{2}$ to 3in. up to 20ft. in length. From experiments made by Messrs. David Kirkaldy and Son, of London, it was shown that the limit of elasticity of these shafts was 79,200lb., that of ordinary iron being 23,800lb., and of patent rolled shafts 60,600lb. The relative strength therefore is, iron 1,000lb., rolled shafts 1,505lb., compressed polished shafts 1,612lb. They can be used wherever turned material is now employed.

The Burgenstock Mountain Railway.—In an article in the *Schweizerische Bauzeitung*, Prof. Denzler gives some notes on the behaviour of the electric plant which operates the inclined railway and furnishes the current for the lamps on the Burgenstock, on the Lake of Lucerne. He states that the probability of a disturbance of a line depends not only on its length, but also on the difference in potential at the primary machine, the difference in elevation of the portions of the conductor, and the proximity of the line to a place exposed to violent thunderstorms. The effect of a difference in height and a difference of potential at the primary machine is well marked at the Burgenstock, where the generating plant is 1,640ft. lower than the secondary machines. When the upper station is enveloped in a thundercloud the discharges are much stronger and more frequent than when the clouds are higher. If the storm takes place during the day, when the electricity is employed for the railway only, the discharges are much less powerful than at night when the lamps are in the circuit.

Oxford.—The Oxford City Council held a special meeting last week to consider the two proposed provisional orders for the electric lighting of Oxford, and after receiving the report of the General Purposes Committee, unanimously passed a resolution assenting to the proposed order of the Electric Installation and Maintenance Company, Limited. Mr. Alderman Deazeley explained the system upon which the company intend to carry out their scheme, and also referred to the terms upon which the city may, if so disposed, acquire the undertaking. Some of the members of the Council, no doubt alarmed at the recent reports from New York of the accidents resulting from the electric wires in that city, wished for information upon the question of danger, but Mr. C. Underhill allayed their fears by describing the system adopted by the company as the safest and best that it was possible to devise, and declared that all wires would be safely laid underground, and, in addition, the current employed would not be dangerous. Under the arrangement the Council have option of purchasing the property at any future time at a fair price if so disposed.

Electric Omnibuses.—Mr. Radcliffe Ward, writing to the *Financial News* with reference to electric traction, says his electrical omnibus has several times passed opposite the Mansion House during the most crowded times of the day. Such a fact speaks for itself; in fact, from one point of view, the thicker the traffic, the less work in guiding there is to do. For instance, during crowded times of the day, the vehicles in Cheapside may go the whole length of the street without getting out of line. Electrical omnibuses can be stopped more easily than the horse vehicles. There is one important point in their favour—the present experienced omnibus drivers will be the men to drive them. No driver, after getting accustomed to the comfortable little box—from which, at perfect ease, he will manipulate his electrical vehicle—will ever want to go back to the driving and holding up of horses. As regards cost, if 50 omnibuses are worked from one centre (a moderate number), it can be done, including all cost of maintenance, at 3d. per mile. It is said that ½d. per mile saved on the London General Omnibus Company's cost of traction would double their dividend. It is not only omnibuses, but goods carts and carriages of all kinds that will soon be operated by electricity, with great benefit to all concerned in street traffic, local authorities included. The saving in wear and tear of streets will be great, as well as in scavenging.

Alternate Current Lighting in Italy.—The great natural advantages in Italy, due to the presence of numerous waterfalls, have resulted in a wonderful development of electric lighting stations, most of them being not unnaturally high-tension alternating-current systems of distribution. The following list of Italian central electric stations is given by the *Bulletin Internationale*:

Town.	Motive Power.	System.	Capacity in kilo-watts.
Tivoli	Waterfall	Gaulard	6
Milan	Steam	Zipernowski	150
Rome	ditto	ditto	1,440
Turin	ditto	ditto	300
Bagni	Waterfall	ditto	15
Trevise	ditto	ditto	60
Terni	ditto	ditto	240
Palermo	ditto	ditto	40
Lonato	ditto	Rivolta	30
Livorno (Leghorn)	Steam	Zipernowski	240
Taglicozzo	Waterfall	ditto	15
Perdehohe	ditto	ditto	30
Bassano	ditto	ditto	50
Syracuse	Steam	ditto	150
Cimeo	Waterfall	ditto	150
Schio	ditto	Oerlikon-Kapp	50
Alzano	ditto	Zipernowski	100
Rome-Tivoli	ditto	ditto	800
Venice	Steam	ditto	160

From the above it will be seen what a large number are enabled to obtain power from waterfalls. At Schio, the 420 lamps of various powers are supplied from a single converter placed in the centre of the town. At Lonato and at Tivoli the transformers are in series, while in the other towns they are in parallel.

Safety in Electric Lighting.—Sir William Thomson, in an article in the *North American Review*, says that: We are forced to conclude that in laying down regulations, and in arranging for careful inspection to secure their fulfilment as far as practicable, the advisers of the British Board of Trade felt that the danger from high-pressure overhead wires could not be absolutely annulled. This view is confirmed by the fact that in most or all cases in which provisional orders under the Electric Lighting Act of 1888 have been granted to companies for the electric lighting of cities or districts of cities, it has been stipulated that the conductors shall be altogether underground, except in cases in which aerial wires have already been placed and brought into action, and that even in these cases the conductors, if for high-pressure supply, shall be removed from the air and replaced by underground conductors within two years. It may be considered, indeed, as now definitely resolved that the distribution of electric energy for light and power in towns of the United Kingdom shall be by underground conductors, and plans for carrying this into effect safely and economically are engaging the anxious consideration of electrical engineers. The telegraphic department of the Post Office has already replaced nearly all the aerial telegraph wires of the larger cities by underground conductors. The telephone wires alone remain in the air. Long may they hold their place there; they are perfectly harmless to the general public, and they are enormously less expensive where they are than they could be if placed underground. As for the country, telegraph, telephone and electric light conductors must all be in the air, the cost of placing them underground would be absolutely prohibitory of the great public benefit to be obtained by placing more and more of them in the air.

Interior Conduits.—The method of wiring houses in England is almost universally in wood casing. A method, however, is introduced in America by the Electric Supply Company, of Chicago, which may have a useful field, especially in such houses as are required to be specially fireproof, as in theatres, for instance. The system consists primarily of a highly insulating and weather-proof tube, made in various sizes from ¼in. to 1¼in. inside diameter, and in uniform lengths of 10ft. When these conduits are laid throughout a building, they form a convenient and permanent moisture and electrically fireproof channel, through which the electric conductors may be inserted by means of fishing wire, or withdrawn, if necessary, without inconvenience or injury to wall or decoration. All danger to property by fire from electricity is obviated, as the high insulation will prevent any dangerous leaking of the current. The tube leads to junction-boxes, in which porcelain cut-outs are placed, and these boxes may be located where most desirable. The covers of the boxes are made either ornamental or perfectly plain, and as they are flush with the wall they may be decorated to correspond with it. Branch junction-boxes are placed where branches are required, and which allow ready access to any desired section. This system has been approved by the Board of Fire Underwriters in New York, Boston, and Baltimore, and will meet with the approval of all boards when this system is brought to their notice. The prices of the tubing are extremely low, and when the ease and readiness with which wires may be laid are considered, the expense is not greater than that attending the old methods of wiring. This system of conduits is now being placed in a large number of handsome buildings in course of erection in Chicago, and in other cities. By its use, an architect would be able to specify a comprehensive system of conduits throughout a building, which will be not only low-priced, but thoroughly reliable and easily accessible, and can be laid beneath plaster in the same manner as gas or water-pipes.

Transport Ship Lighting.—The steamship "Orel," owned by the Russian Transport Company, has just been fitted up with electric light by Messrs. J. H. Holmes and Co. The dynamo, a slow-speed "Castle" machine, is coupled direct to a vertical engine, and gives 130 amperes and 105 volts at 180 revolutions. The commutator is of hard-drawn copper, insulated by mica, and having an extra large brush surface. The current is taken off from the commutator by means of brushes of copper gauze, and a spring pressure is maintained by brush-holders having an adjusted parallel thrust, so that the angle of the brushes cannot alter with the wear. A special sight-feed lubricator is fitted. The field-magnets are made of soft wrought-iron bars which have been annealed with great care, while the yoke is of cast iron, but of increased section to give the same magnetic circuit. The yoke is so arranged that the field-magnets can be divided and one half removed by merely taking out the bolts without interfering with the connections, so that the armature may be removed sideways. The self-regulation of this machine is such that between no load and full load the voltage does not vary more than 2 per cent. The ship contains a total of 210 lamps. The wiring and fittings are somewhat interesting from the care bestowed upon their arrangement in certain portions of the ship to withstand rough usage. All the cables employed in the emigrant and crew space, engine-room, etc., are heavily armoured, and are therefore practically indestructible. The branch joints are covered in cast-iron boxes, and the fittings have been specially made to withstand very rough usage. In the portion occasionally used for cargo the lamps are made removable, so as to be detached when required. The fittings in the first-class saloons are of handsome design, electro-plated, fixed on polished wood bases. The second-class fittings are bronzed, but otherwise similar to those in the first-class cabins. The signal lamps are each fitted with two lamps in case of extinction. Great attention has been paid to the details, and the installation is a very complete and successful one.

The Southwark Subway.—The Southwark underground electric railway was officially and publicly experimented upon on Wednesday, the Lord Mayor and a number of press representatives and other gentlemen taking part in a trial trip along the line. The public and the electrical engineering profession have long been awaiting the result of this undertaking which is expected to inaugurate the new era of electric railway travelling, and, although the line is far from complete, the arrangements are forward enough to allow of an experimental train running its length from the Monument to the Elephant and Castle. Both the cars employed on this occasion and the generating plant were temporary. The cars were similar to ordinary tramcars, handsomely upholstered, but with semi-circular roofs. It is interesting to state that, unlike the Metropolitan Railway, all the cars on the subway railway will be run Pullman car fashion, and it is rumoured that the fares will be collected along the route instead of booking beforehand, with uniform fares for several distances, and no distinction of classes. The electric locomotive is 100 h.p. The current is supplied at 450 volts. The stations and the trains themselves will, of course, be also lighted by electricity. While passing under the River Thames the train is only 30ft. from the bed of the river. The construction adopted, which we have already alluded to, of a solid iron tubing 10ft. in diameter embedded in the solid clay, gives very little fear of any danger. In some parts the railway is as much as 70ft. or 80ft. below the surface of the ground. At present the descent is by circular staircases amongst building *débris*, but the huge hydraulic lifts intended for the stations are being rapidly proceeded with. Tests have shown that the locomotive and carriage can travel at 25 miles an hour, or the locomotive alone at 30 miles an hour. In practice, however, it will be run at less than full speed—15 miles an hour, including stoppages. There will be four intermediate stations, Great Dover-street, Elephant and Castle, Kennington Park, and the Oval, besides the termini at the Monument and Stockwell. The distance is 3½ miles, and this in ordinary running will be done in 13 minutes. On the trial trip on Wednesday the Elephant and Castle was reached in 3min. 56sec. A wait here was intended of only a few minutes, but owing to the bursting of the water company's pipe near the engine-room, the water was unfortunately turned off and steam ran low, making the wait extend to over an hour. Presently, however, the cars were ready to return, and the journey back was expeditiously made, the directors meeting the visitors afterwards in a dinner. The trip conclusively showed the immense gain to travellers in South London, and that when completed Messrs. Mather and Platt will have scored one of the greatest successes in electric traction.

ELECTROLYSIS OF PLATINUM SALTS.

BY ALEXANDER WATT.

(Continued from page 167.)

In experiment 2, described in the preceding paper, an electrolyte was prepared by neutralising bichloride of platinum solution with chalk, as it was thought that possibly a perfectly neutral solution of this salt might prove useful as a platinum plating bath. Following up the plan of neutralising the chloride, with this object in view other substances were subsequently tried, one or two of which gave rather promising results. It should be mentioned, however, that when bichloride of platinum is carefully evaporated to absolute dryness in the manner before suggested, it requires but a very small quantity of any alkaline salt to effect the object. In giving directions for the preparation of the bichloride, it is sometimes recommended to continue the evaporation of the deep red solution nearly to dryness; but according to my view this is not sufficient, since I have found that when the metallic salt is entirely freed from all the acid and water, the resulting dry salt, when dissolved, yields a solution which is far more suitable for electrolytic purposes whether to be used *per se* or in the preparation of other salts of which platinum is to be a constituent. The effect of perfect evaporation to dryness is seen in a remarkable degree in the preparation of chloride of gold, as I have shown in former writings, but more especially when the gold chloride is to be used for making up gilding baths or for photographic purposes, as in the preparation of "toning" baths. When used for the latter purpose the well-dried chloride of gold is capable of toning five or six times as many photographic prints as the ordinary chloride crystals of the shops, besides yielding a superior tone or colour to the prints.

In some of the following experiments the aim was to put the solution of bichloride of platinum in such a condition that it might be advantageously used as a platinum plating bath for practical purposes, as it was thought that such a solution would have the advantage of being very readily prepared, and would require but moderate attention to keep it in good working order.

9. *Platinum Bichloride Neutralised with Ammonia.*—A solution of the bichloride containing metal to the extent of about one ounce per gallon was first prepared, and to this liquid ammonia was gradually added, drop by drop, until the liquid was neutral, or faintly alkaline, to test paper. A very small quantity of ammonia only was required. The solution, thus prepared, was electrolysed with the current from three small Daniells, a platinum anode and a clean brass plate as the cathode being used as before. On immersing the electrodes, the brass plate at once received a bright and perfectly uniform coating of platinum of a good white colour, and it was found, on scouring the plate at this stage, that the metal adhered well to the brass surface, the platinum having in fact alloyed itself with the brass. A freshly-cleaned plate being left in the bath for an hour or so acquired a fair coating, and there was no tendency to the formation of the black powdery deposit. As before observed, however, in using a solution of this character the liquid will necessarily assume an acid condition when a portion of its metal is removed from it during electrodeposition; consequently, an addition of ammonia would be required whenever the liquid exhibited an acid reaction on blue litmus paper. If, however, the system of circulation before referred to were adopted, the neutralisation and strengthening of the solution would be effected outside the bath itself, so that no disturbance of the working electrolyte need occur.

10. *Platinum Bichloride Neutralised with Carbonate of Soda.* A solution of the bichloride, of the same strength as before, was neutralised by gradually adding to it a solution of carbonate of soda. With the current from two cells a metallic film slowly formed upon a brass plate, but as the deposition was rather too slow for a good result a third cell was put into the series, when the metal deposited much more readily, the plate being coated in a few seconds. The film was of a good white colour, and firmly adherent. In a bath of this character, if practically worked, there would eventually be an accumulation of chloride of sodium formed in the solution by the repeated additions of the alkali combining with the liberated chlorine, but since chloride of sodium does not unite with platinum to form a double salt in weak solutions of platinum chloride, and, moreover, as the sodium salt is very insoluble in such solution, it gradually deposits and crystallises at the bottom of the bath, whence it can readily be removed as occasion may require.

11. *Platinum Bichloride Neutralised with Borate of Soda.*—A solution of the bichloride of about the same strength as before was neutralised by gradually adding a solution of borax, a slight excess being given. With the current from three Daniells a deposit of platinum rather slowly formed on the brass plate, when it was considered advisable to add another cell, which being done, a bright film of the metal quickly deposited on a newly-cleaned plate, and a very uniform coating of good colour was obtained. The plate being left in the bath for some time presented a perfectly uniform surface, free from any kind of irregularity, even at the lower corners, where the deposit is apt to blacken if there be any tendency in that direction. A bath of this constitution, though requiring a rather strong current, might be available as a depositing solution as it is readily prepared, works very uniformly, and can easily be maintained in a neutral condition and of the proper metallic strength by the circulation method before noticed. It should be mentioned that after a time a slight yellow stain appeared on the surface of the platinum anode, but this is easily removed by scouring. There was very little gas given off at either electrode. It is probable that a somewhat stronger solution than that above described would prove advantageous, but as a rule rather weak platinum baths seem to yield the best results.

12. *Chloride of Platinum Neutralised with Magnesium Carbonate.*—A solution of the bichloride was neutralised by gradual additions of carbonate of magnesia, and the resulting liquid was then tried with the current from three Daniells, when a deposit resembling "blued" steel was first obtained, but after a time the film assumed the ordinary colour of platinum. I may here state that platinum not unfrequently commences to deposit of a blue colour from certain solutions of the metal, and while in a few instances the film maintains this appearance, even after a long immersion of the plate, in most instances it is followed by the metal assuming its proper colour, except that in such cases it is generally of a somewhat darker tone than that of pure platinum. A bath of this composition cannot be recommended, however, for practical use, as the deposited metal does not adhere very firmly to brass. Indeed, some of the deposits obtained could easily be removed from the plate by rubbing with the finger.

13. *Platinum Chloride Neutralised with Carbonate of Potassa.* To a solution of the bichloride of platinum was gradually added one of carbonate of potash, until the liquid became slightly alkaline. With the current from two cells a deposit soon formed on the surface of a clean brass plate, the film being of a good white colour and very adherent. A bath of this composition might be used, but since there would eventually be an accumulation of chloride of potassium in the solution, and as this salt forms an insoluble yellow double salt with the platinum, it can scarcely be recommended for practical purposes.

14. *Platinum Bichloride in Cyanide of Potassium.*—A solution of the bichloride was added to one of cyanide of potassium, when after a time a yellow deposit, insoluble in the cyanide, formed. The supernatant liquid was then poured off, and electrolysed with the current from three cells, when it was found that very little metal deposited. Though a better result was obtained on warming the solution, the bath was not found to be so favourable for practical purposes as some of those mentioned elsewhere. During the electrolysis there was a considerable evolution of gas at the negative electrode.

15. *Chlorides of Platinum and Ammonium in Caustic Potassa.*—The double yellow salt formed by mixing solutions of bichloride of platinum and chloride of ammonium was treated with a strong solution of caustic potash, and the liquid heated, when the double salt soon dissolved, forming a nearly colourless solution. When diluted and

allowed to cool, the compound solution was electrolysed with the current from three cells, but very little metal became deposited. A fourth cell was therefore connected in the series, when deposition proceeded somewhat more rapidly, but still too slowly for any practical use. The liquid was therefore cast aside.

16. *Bromide of Platinum.*—To form this salt a solution of bromide of potassium was gradually added to one of bichloride of platinum, when a deep red solution resulted, while a slight precipitate of a deep red colour deposited at the bottom of the vessel. The clear solution being poured off, the precipitate was electrolysed with the current from two cells when a bright deposit of platinum formed on a brass cathode, the metal being of good colour and very adherent, the first deposited film having alloyed itself with the brass. This solution was found to be a very good conductor, for even with the current from a single cell a brass plate slowly became coated with a thin film of platinum. The colour of the deposit was not so good, however, as when the two cells were used. The red precipitate separated from the foregoing solution was afterwards treated with hot water, which was found dissolved it freely, forming a yellow solution. This latter was in its turn electrolysed with the current of two cells, when a brass plate soon became coated with metallic platinum. A solution was afterwards prepared in the reverse order by adding a solution of the bichloride of platinum to one of bromide of potassium, both solutions being pretty strong, when a very deep red liquid at once resulted, and there was a considerable disengagement of bromine. The liquid was then moderately heated, and afterwards set aside to cool. When some time after examining the vessel in which the foregoing mixture had been made, it was found that bromine was still given off freely, and that the interior of the vessel had become coated with a film of metallic platinum. In fact, nearly the whole of the metal had been thrown out of the solution by the chemical action which supervened when the mixture referred to had been heated.

17. *Bromide of Platinum in Cyanide of Potassium.*—A solution of the bromide was prepared as first mentioned in the preceding experiment, and to this was added a solution of cyanide of potassium, which instantly decoloured the liquid. The solution thus obtained was then tried with currents of varying density, but little or no metal was deposited, so the solution was abandoned.

18. *Sulphide of Platinum in Cyanide of Potassium.*—A quantity of sulphide of platinum was first prepared by adding a solution of sulphide of ammonium to one of platinum bichloride, and the brown precipitate, after being washed, was treated, while still moist, with a rather strong solution of cyanide of potassium, which appeared to have but little effect in the cold. When the mixture was heated, however, the sulphide instantly dissolved, forming a brown solution. This was now electrolysed with the current from four cells, but the solution failed to yield a metallic deposit. After a short time a black precipitate formed at the bottom of the vessel, when the bath was cast aside.

19. *Chlorides of Platinum and Potassium.*—When solutions of the respective salts named are mixed, a yellow double salt is precipitated; but a small proportion, however, remains in solution. A quantity of the double salt having been prepared, the supernatant liquor, which was of a yellow colour, was electrolysed with the current from four cells, but only a very slight deposit of metal could be obtained. The yellow double salt was next dissolved in a boiling solution of pyrophosphate of soda, and the resulting solution, when cold, was electrolysed with the current from two cells, when a deposit of platinum formed on a brass plate, the colour of which, however, was rather dark. After a time the double salt again separated and deposited at the bottom of the vessel. The metallic deposit obtained did not adhere to the brass plate.

20. *Bromide of Platinum in Pyrophosphate of Sodium.*—A strong and hot solution of pyrophosphate of soda was first prepared, and to this was added some freshly-prepared bromide of platinum, heat being applied, when a nearly colourless liquid resulted. This was tried with the current of four Daniell cells, when a deposit of platinum, of rather a dark colour, gradually formed upon a brass plate. It was noticed that a yellow salt formed on the surface of the anode, which instantly dissolved in the solution, however, directly the circuit was broken. The platinum deposit from this solution was very adherent.

21. *Sulphocyanide of Platinum.*—When a solution of bichloride of platinum is added to one of sulphocyanide of potassium, an orange-coloured liquid is formed, from which after a time a slight precipitate of a yellow colour deposits. A solution obtained as above was electrolysed with the current from three cells, when a patchy deposit of platinum of a dark colour slowly formed upon a brass plate, but after a short time the liquid surrounding the anode acquired a deep orange colour, the whole of the solution eventually assuming the same tone.

22. *Chlorides of Platinum and Strontium.*—A solution of the strontium salt was added to one of bichloride of platinum, and the liquid electrolysed with the current from three Daniells, when a deposit of platinum, of a blue colour, formed upon a brass plate, but after a time the metal acquired the characteristic colour, though not quite so white as that of the pure metal.

(*To be continued.*)

THE WEYMERSCH BATTERY.

When some time ago particulars were published of the new constant-current battery for heavy currents invented by M. Weymersch, these particulars and the tests then made showed that the battery was one which was likely to occupy a very useful field where large and steady currents were required, and expectations were raised that the battery would prove to be one which would be really applicable to those cases where a private electric installation is required without the trouble of dynamo and machinery. When also it was known that the India Rubber and Gutta Percha Company, of Silvertown, were impressed with the advantages of the battery, and were devoting some time and trouble to perfecting, in co-operation with M. Weymersch, its mechanical and other details, it was also expected that a practical and commercial result would accrue from such endeavours. These expectations have, we are pleased to say, been realised, and arrangements have been made both to push the battery commercially in such fields as it can prove itself to be useful and practical, and also manufacturing arrangements have been made with the Silvertown Company to turn out the batteries in quantity and of such material and design as shall ensure its being both scientifically well made and arranged, and of moderate cost to user.

The Weymersch Electric Battery Syndicate have now taken offices at 2, Victoria-mansions, Westminster, where they have a very interesting exhibit showing the battery as it is supplied, with several rooms lighted up with some dozen or more incandescent lamps of 10 c.p. in electroliers and brackets, with separate standards with battery combined for hall or studio, and also a Planet arc lamp of some 400 c.p. giving a beautiful and steady light, all run off the same set of batteries, which are arranged exactly as for ordinary working in an adjacent room.

The battery has already been illustrated and described, but has been finally modified and arranged as shown in the present illustrations. It is a double-fluid battery, of which the one fluid is a very dilute solution of sulphuric acid, one in 20, and the depolariser is a dark-coloured acid liquid, which is supplied by the makers in either solution or for export in solid salts. The standard size of battery is made in teak boxes, each containing six cells, joined in parallel by the peculiar arrangement of discharge pipes adopted, so that they can very easily all be emptied by the simple turning of a tap. The standard set for lighting comprises six of these batteries, giving something over seven volts when supplying fifteen amperes on the lamps. In use the most economical method is to employ two standard sets in series with 14-volt lamps; this will give 15 amperes constant current for 18 hours, with a drop of only 5 per cent., supplying eight 14-volt lamps of 8 or 10 c.p.

The special peculiarities of this battery, besides this constancy for large currents, are the arrangements adopted for quick and easy filling, emptying, and renewal of the charging solutions with the least possible trouble or labour. Each standard battery is, as shown in the illustration, formed of six small cells, measuring over all about 2ft. 8in. by 9½in. by 1ft. 4in., each cell being divided into a central porous receptacle to contain the carbon element, and two outer receptacles to contain the two zinc elements. The elements are of large surface and unusually thick, so that they seldom require renewing. Each porous cell is connected together by means of an ebonite pipe, terminating outside the teak case in an ebonite tap and gauge glass; so arranged that on filling the porous cells with the depolarising liquid the level of solution is at once seen upon glancing at the gauge glass. The outer cells containing the zinc elements are likewise connected to another ebonite pipe, with its outside tap and gauge glass for a similar purpose.

FIG. 1.

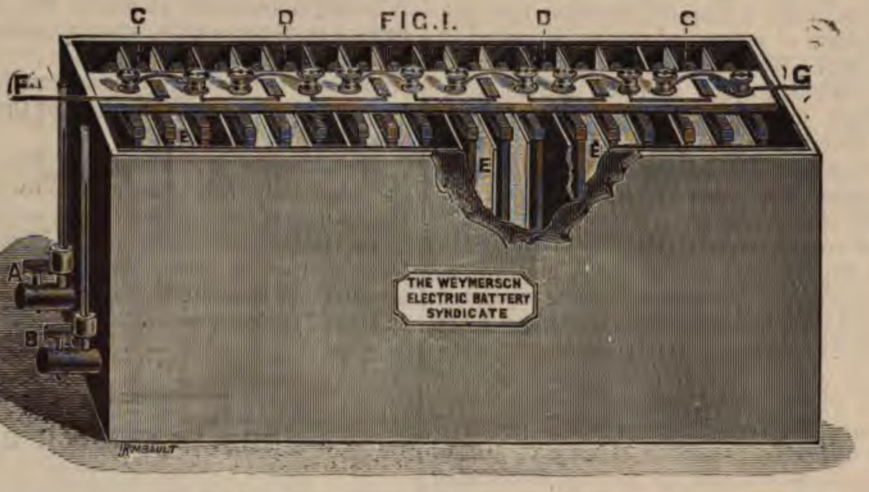
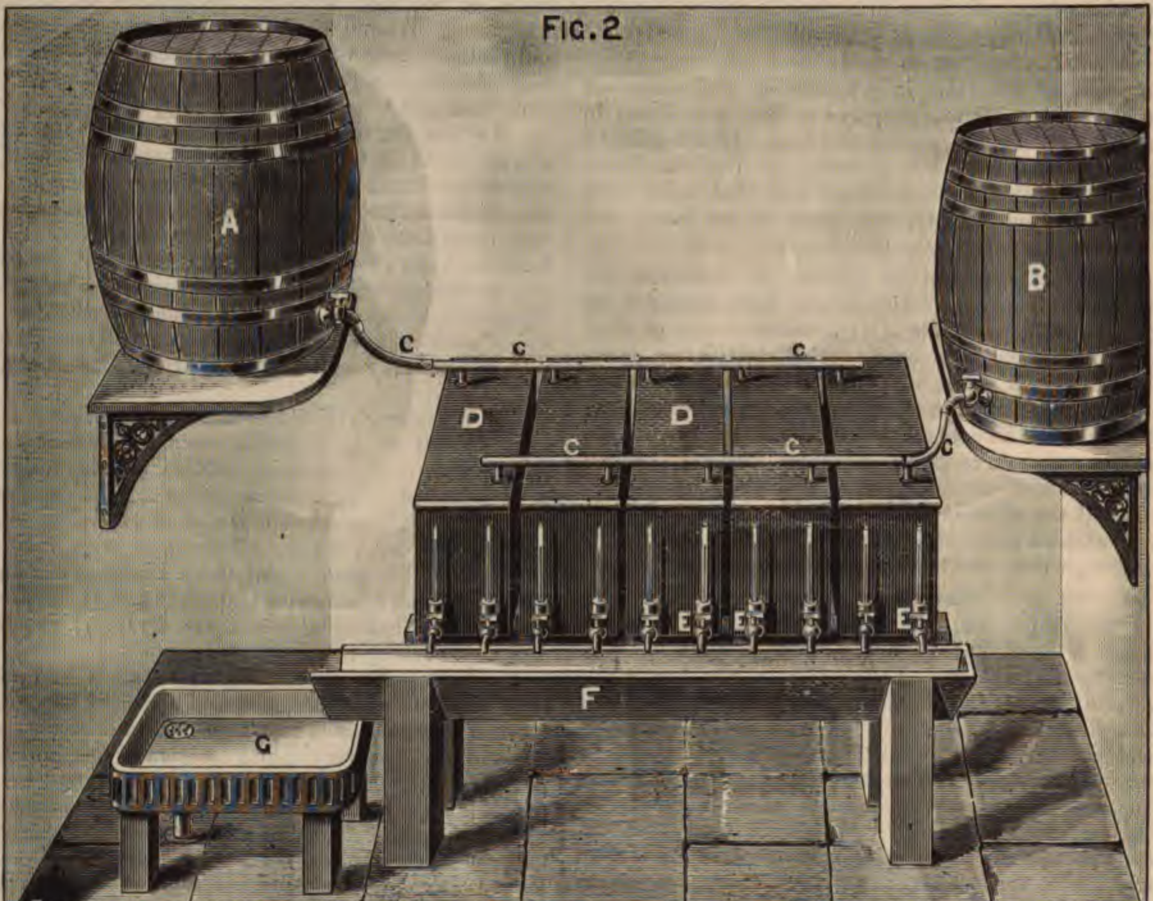


FIG. 2



The zincs are sent out specially amalgamated, and if the current is not allowed to exceed 15 amperes they will not require re-amalgamating.

For filling, two large casks (of stoneware or specially prepared linseed-oil casks), holding from six to 40 gallons, are arranged, as shown, on a higher level than the batteries. These are fitted with taps and indiarubber tubing. One cask is filled up with water, by a suitable water-tap arranged near it, and then two gallons of strong sulphuric acid are poured in and stirred up. The other cask is filled up with the depolarising fluid. To fill the batteries, therefore, all that is necessary is to insert the tube and nozzle into the batteries and turn on the tap, the gauge in front of each battery showing the height of the fluid. To empty the battery, the taps on the batteries are turned and left running; the liquid drains off by means of an earthenware trough.

In practice the depolariser will last for a total run of 18 hours, which may, if desired, be spread over three or four days; but the dilute acid is run off every night and filled up again fresh in the morning. The whole operation of emptying and charging a battery takes considerably less than half an hour, and can be done by anyone who can turn taps on or off and notice the height of the gauge glass.

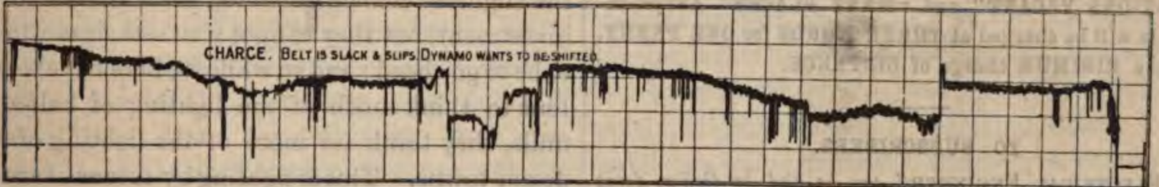
Each standard of six cells gives on open circuit 13 volts, and has a total internal resistance of ·30 ohm, giving a maximum current of 15 amperes for 18 hours. If this current be not exceeded there will be a total absence of all fumes. The depolarising solution is very cheap, costing but a few pence per gallon, and can be well sold at a shilling a gallon. One gallon will give 1,000 watt-hours.

Besides the above, which is made for ordinary house lighting, smaller sized batteries are made for 16 volts and 6 amperes; for 12 volts and 4 amperes; and for 8 volts and 3 amperes. These are supplied either in cheap cases, or more ornate for places when they will be in sight. Suitable outside ornamental cases in oak, walnut, or other fancy woods, carved or plain, are supplied, with wrought-iron, or chased copper and brass standards to carry the lamps.

The cheap form can be placed under a table or in a cupboard, and the wires led to brackets which hold the incandescent lamps.

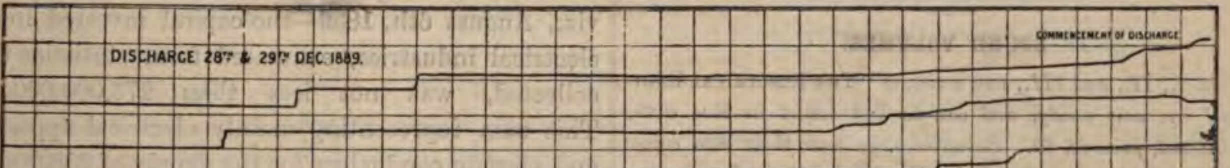
A still smaller battery is made for bedroom night-lights, miners' lamps, etc., capable of giving about 2 c.p. for ten hours, and weighing about 5lb.

The first cost of these batteries is moderate, being about £1 a cell, so that the installation of what may be termed an ordinary small house—where eight or 10 lamps could be kept burning and perhaps up to 12 or 15 wired—would be not more than about £25, including batteries, fittings, and lamps. In the case where a small arc lamp is required and where no power is to be obtained, this battery ought be very useful. In this case five sets of six batteries would be required in series. The question of cost in maintenance has been gone into, and it is maintained that light can be produced, including an allowance for labour in filling, solution, renewals, etc., for $\frac{4}{10}$d. per lamp hour. The cost of the current for arc lamp works out at 1d. per 100-c.p. hour. We are not, of course, in any way able to guarantee these figures ourselves, but we believe that one of the great railway companies have taken the battery to experiment upon with the idea of comparing its expense with the present system, and have fitted a couple of sets in their trains. The system does away with the necessity for plant for charging, and attendance; and for train lighting it has the advantage that each carriage can have its own battery. The battery has also been applied to run an electric launch of about 1 h.p. for a gentleman in Chester.



Recording Voltmeter.—Diagram of Charge.

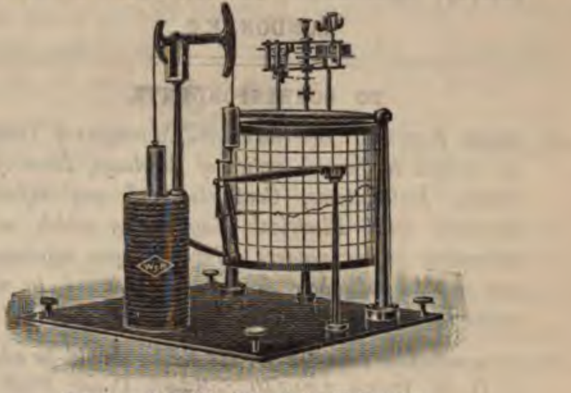
There is, of course, no intention of competing with large installations of dynamos and engines, but electrical engineers have always found there are a certain number of enquiries for small primary battery installations, and have often been nonplussed as to what form of battery to recommend. In such cases as we have indicated, or where houses are far from supply of gas and an electric current is desired, it seems probable that the Weymersch battery will afford a solution of the difficulty, both on account of its constancy and the simplicity of manipulation, for installations requiring up to a total of 1,000 c.p. in incandescent lamps. The exhibition at Victoria-mansions is a very interesting one, and those who are interested in the future development of primary battery working will no doubt visit the Weymersch battery installation.



Recording Voltmeter.—Diagram of Discharge.

RECORDING VOLTMETER.

The instrument illustrated herewith is a recording voltmeter, which is adapted for keeping a record of (1) the discharge E.M.F. of accumulators, or (2) the E.M.F. on any ordinary circuit. It thus forms a means of checking the attention of the attendants, the efficiency of the regulation of source of supply, and lastly, the condition of the battery as a whole can be seen at a glance by looking at the curve formed by the needle. Further, should it be stated by the consumers that the proper E.M.F. was not supplied on any date or time, the curve corresponding to the particular period may be referred to, and the whole question settled at once.



Jones and Hall's Recording Voltmeter.

The apparatus consists of a core dipping into a solenoid, connected to a lever, working on a pair of supporting pillars, and parallel-motion connecting rods, which support the inking needle. The needle holds a supply of blue aniline ink in a small reservoir. The registering part consists of a revolving drum, on which the paper is fastened daily, the whole drum with the clockwork which drives it, lifting out bodily, so that fresh paper may easily be put on.

The diagrams shown are taken from actual practice. The straight line diagram shows the form that may be expected when the cells are in good working order, while other curves will show the result when the cells are in a bad condition. The charging curve, when a gas engine is used, also indicates how many times the engine misses explosions, whether the belt slips, and other particulars.

With 105 volts pressure on mains, the current used in the solenoid is only about ·08 ampere. The instrument is manufactured by Woodhouse and Rawson United, and was designed by Messrs. Reginald J. Jones and H. E. Hall, and has been working well for nearly a year.

Appointment.—We see it is announced that Dr. R. M. Walmsley has been appointed professor of electrical engineering in the Heriot-Watt College, Edinburgh.

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We may occasionally follow the lead of our American Contemporaries, especially when they point out a serviceable way. They are not backward in asking their friends to do all they can for the welfare of the paper. We ask our friends to remember us. No paper that we know ever refuses Subscribers or Advertisers. Nor do we; in fact, we invite them, believing that they will get full value for their money.

Specimen copies of the paper will be sent on request.

AMERICANS IN CONVENTION.

The report of the National Electric Light Association convention held at Kansas City, on Feb. 11, 12, 13, and 14, occupies a large part of the American technical press. It is impossible for us to give a full report of the papers read and discussed, and we have taken this opportunity of referring to them somewhat generally. It will be found that our American cousins are very utilitarian in their views: their chief aim at these meetings and in the papers and in discussion seems to be to arrive at improvements in practice. We in England are ofttimes too prone to laugh at the rough and ready methods pursued in America, and to point out that our practice in many things is highly superior, and, perhaps, more elegant and safe, than that pursued across the Atlantic, but, as a rule, while we on this side are procrastinating and waiting the time when all things shall be perfect, the Americans make the best of what they have, and are hard at work. There is no doubt whatever that all the booming of the Americans is due to the extraordinary rapid progress of all that concerns electric light and electric transmission of power. We freely admit their insatiable energy, their willingness to find any amount of dollars provided there is the slightest chance of seeing some return for their investment, but they cannot wait—their motto seems to be to go ahead; and so while we here have been content to think much of the lighting of half-a-dozen mills, they think no more of the lighting of half-a-dozen towns. This is lighting by means of arc lamps and distributing by means of overhead wires, the simplest of all arrangements. We must not forget also that the industry has not had to contend, to so great an extent, with so keen a competitor in artificial illumination in America as gas is to the industry in England. In America gas is either very dear or has not been introduced into many of the new towns, thus leaving the field of operations pretty open.

According to the report of the committee to petition Congress for the abolition of duty on copper, we are told that at the time of the last convention—viz., August 6th, 1889—the capital invested in the electrical industries, estimated from statistics then collected, was not less than 275,000,000dols. This sum representing mainly electrical apparatus and electric conductors for the supply of 238,000 arc lamps and 2,700,000 incandescent lamps, in all which apparatus and conductors copper is an indispensable and chief material. We can easily see, then, how desirable it is to the industry in America that there should be no duty on copper. There seems to be a general feeling that the committee will be successful in their work. Another report is on a subject quite as interesting on this side of the Atlantic as in America. It was that of the committee on standardising of potentials. The report refers more directly to the practice in America so far as regards electric traction, and as a special paper on this subject was read by Mr. Sprague, the discussion was not taken upon the report, but upon his paper. Another question which was productive of a good deal of discussion was the report of the committee on harmonising insurance and electric lighting interests. This, again, is an exceedingly interesting question, and perhaps more so in America than in England, although our readers are pretty fully acquainted with the fact that if the insurance companies in England do not work quite harmoniously with the electric light companies, the harmony is very much greater than it is in America. It must never be forgotten that it is the insurance companies that have to pay in case of an accident, and while that is the case, electrical companies are bound to look with a certain amount of leniency upon the rules and requirements issued by the insurance companies for guidance.

Among the practical papers read and discussed was one by Mr. Woodbury on the construction of central stations. It is doubtful if any general rules can be laid down for guidance in this direction, inasmuch as the site for a central station will in itself frequently require a certain procedure to be carried out. A portion of the question is of considerable interest. Wherever we have heavy machinery it is necessary to have very solid foundations. The foundations should be constructed in such a manner that the vibration from the machinery should be conducted as little as possible to the walls. In some cases a distinct space is left between the foundations for the walls and the foundations for the machinery, and trials have been made to interpose material to take up—if we may be so allowed to term it—the vibration. The most important point in Mr. Woodbury's paper perhaps was that relating to the insulation of the foundations from adjoining structures or from the earth. Papers were read by Mr. F. E. Sickles on "The Steam Engine," and Mr. G. H. Babcock on "The Economical Generation of Steam for Electric Light Stations." Reference was made to the Vienna installation of Messrs. Crompton and Co., in which eight Babcock and Wilcox water tube boilers are employed, when it was stated that 77·59 per cent. of the indicated horse-power was delivered in electrical horse-power. The engines used are Willans direct high-speed engines. The papers brought out the peculiar requirements of electric light stations for boilers and engines. A paper on a somewhat similar topic, only of a more general character, was that of Mr. Field, the title of whose paper was "The Development of Generating Stations for Incandescent Light and Power." Other papers were read on "A System of Station Accounts," by Mr. T. C. Smith; "Cost of Products to Central Stations," by Mr. A. J. De Camp; "Nine Years with the Arc Lamp," by Mr. Law; "Carbon Tests," by Mr. Peck; while Mr. Pope read a paper on "How our Paths may be made Paths of Peace"; and Prof. Elihu Thomson on "Safety Devices." It will be seen that, as we have said, these papers all have a more or less direct bearing upon the practical part of the industry. Then came other papers which we shall attempt to give at some greater length. One of these we refer to in this week's issue, Mr. Sprague on "Electricity as Applied to Street Railways." Mr. Sprague is well known, and has had a great experience in this direction, and a large number of the electric railways in the States are running under his system.

We have nothing in England that corresponds to these electric light conventions in the States. Our Institution could hardly take up the business questions relating to central station management, although they are of the greatest importance in the success of electric lighting operations. We may have the best dynamos, the best motors, the best transformers, or the best engines, but unless the business is carried out upon what may be termed the best commercial footing, success is impossible. In England we have perhaps made too much of scientific success, in America they probably have made too much of what may be termed purely commercial success, but in the long run the latter is of greater importance than the former. If a company is a commercial success, and pays the shareholders good dividends, neither the shareholder nor the public are going to trouble themselves to enquire as to whether that company owns, or does not own, the very best machinery in the market. It has conclusively proved to them that they own a sufficiently good machine or a sufficiently good system to warrant a continuation of their labours. The formation of an Electrical Trades Section in the London Chamber of Commerce was a step in the right direction, and it may be possible that this section will be able to do as much good for the business part of the industry as the convention we have referred to in America.

CORRESPONDENCE.

COAD'S MINERS' LAMP.

To the Editor of the Electrical Engineer.

Sir,—On reading Mr. Coad's letter in your current issue in reply to mine I think he has done himself no good by his personal allusions to me or his gratuitous sneers. I feel compelled to reply, but will be as brief as possible. I am not aware that I am a lunatic (as per his opening paragraph), I am not the iron battery man (that was Mr. A. R. Bennett, I think), I have no interest in any secondary battery system, I am not one of the disappointed rivals. I am only an electric light contractor and maker of electric colliery signals. My work is principally for colliery men, and this will explain, I think, all that Mr. Coad tries to create a laugh about. "My authorities for lamp weight should be," etc., are the men who are responsible for, and have almost daily to inspect the underground workings, etc. I do not care to mention names, for reasons obvious to most business men. In return, I ask Mr. Coad for his authority for a statement which certainly only those well knowing colliery owners personally or by business relations can truly make, that "every colliery owner first considers the safety of the miners and his property; price is of secondary importance." My experience on this, like other matters, reminds me that the millennium has not yet come. It is one thing to study in one's own sanctum, another to come in contact with the men we write about. But let Mr. Coad imagine himself a colliery owner, then ask and answer the question: "Will I, though scarcely able to pay my way now, greatly increase my expenditure for fear an oil lamp might possibly imperil other lives and my own property." Some men's consciences would answer "Be first just, then humanitarian," but, of course, these are an inferior order of beings. The lens I, of course, quite understand—my former remarks were intended to elicit an explanation from Mr. Coad himself. Lenses are well enough in their way, but they do not increase light any more than a funnel, say, 6in. at the top ½in. at the bottom, increases a pint of water poured into it—it merely increases the force of the stream. We know how a lens merely makes the light that would fall on, say, 20 square feet fall on one with, of course, greater intensity. Therefore—and also because lenses can as well be adapted to an oil as an electric lamp—his (Mr. Coad's) 10-c.p. lamp is only a *genuine* ½ c.p., and my figures *re* oil stand unassailed.

Then secondary batteries weighing 9lb. in place of primary 3½lb. What would Mr. Fitzgerald or Mr. Pitkin say? I have had the pleasure of seeing both these gentlemen's lamps. They weigh, I believe, about 4lb. for the genuine ½ c.p.

In conclusion, I have no ill wish whatever to Mr. Coad; on the contrary, if I am included in his invitation, I shall be glad to call when next in London, and should be only too happy to do anything that might be to our mutual advantage.—Yours, etc.,

A. W. BENNETT.

Leeds, March 3, 1890.

ELECTRICITY AS APPLIED TO STREET RAILWAYS.[*]

BY FRANK J. SPRAGUE.

From 8 a.m. to 9 p.m., a period of 13 hours, 21 regular trains leave the Jersey City Station of the Pennsylvania road to run through to Philadelphia; 12 of these make but one or two stops. The balance make more or less stops according to the running schedule. In addition to these there are a number of local trains serving way stations. Taking the through trains only, and allowing an average of, say, five cars to a train, there are in the 13 hours about 105 through cars despatched from Jersey City, or at the rate of one car every 7½ minutes, and of the through trains not making over one or two stops there would be one every 13 minutes. We will suppose an additional express track has been built, leaving the distance about what it is now, say, 90 miles, but that the grades have been eased and the worst curves rectified. For the practical purposes of this paper I will consider that the road is level, that the cars are to be despatched in two-car units on a perfect block system, and to run through to Philadelphia with not more than one stop, at fixed intervals, and at a high average rate of speed—say 60 miles per hour. In the systems that I would propose, practically that with which I experimented some years ago, slight grades would make little difference in the general result, especially if the grade percentage, if expressed as a whole number, did not exceed the quotient of the traction in pounds per ton divided by 20; because when $c = \frac{t}{20}$ where t = traction in pounds per net ton and c = grade percentage exprassed as a whole number, the work of traction and of lifting are equal. For example, suppose $t = 10$lb. and $c = \frac{1}{2}$ per cent. and that we had on a double track one unit coming down the grade and the other ascending it, both at the same speed. Then gravity would be supplying just enough power to propel the car on the down grade at a fixed speed, and enough power to supply the lifting and traction work of the other car would have to be supplied, which would be just the amount required to propel both cars on a dead level.

Suppose the grade to exceed the ratio expressed above, then the car on the down grade would have an excess of falling energy, and this could be used in accelerating the speed of the car, or on the brakes, or it could be used by a process of reconversion for the purpose of supplying at short range part of the extra energy required by the ascending train. Just how this can be done is pretty fairly understood by electricians, but I will touch upon it again, because it is a feature of vital importance in determining the matter of motor control in a large system such as we are now considering, and because it illustrates one of the most beautiful features of this method of converting energy. No matter whether a machine be used for a motor or a dynamo, whether to convert mechanical energy into electricity or the reverse an armature develops an electric pressure or potential which is dependent upon its speed and the effective strength of the magnetic field in which it is used. If this field is in shunt relation to the armature and in connection with the track circuit, we have, by any of the well-known methods, a means for independently varying the strength of that field. When such a machine is geared to a car, it can either drive the car, acting as a motor, or be driven as a dynamo, and in connection with any other similarly connected motor, or the central station generators, will form an electrical couple, either of which may be driven by, or drive the apparatus to which it is connected. If the couple thus established is between the motor and the central station dynamo, we have at one end a machine driven by a constant-speed engine and generating an approximately constant E.M.F., and at the other end a machine of greatly varying speed and with facility for increasing or diminishing the E.M.F. which it generates. The result is an electrical differential which will establish a current between the two in one direction or the other according as the pressure developed by the motor is lower or greater than that developed at the generating station. If the pressures are equal no current will pass. If the couple consists of two motors thus connected, then we have two apparatuses, each of which is generating a variable E.M.F., and there will be a current between these or not according to their relative electrical pressures. A large system is tied together in the most intimate manner possible. The tracks are cross-connected, the overhead conductors cross connected, and you would have, in effect, what would correspond to two large planes before which was moving, at varying speeds, a number of independent units, these two planes kept at a fairly constant potential by means of the generating station. All motors starting running on a level, or ascending a grade, would be requiring currents. All motors running on a down grade with just that velocity which the force of gravity would give them would require no current, and motors running on down grades of greater percentage than is required to give them power for traction, or motors slowing down, would be generating currents to aid in the general supply. No other system of distribution can by any possibility have this very remarkable interchange of energy. When running at a particular speed a slight movement of a regulating handle would make the motor receive from or give to the line currents in any desired quantity. The braking power of a motor thus acting as a generator is very powerful and the most perfect imaginable, because unlike the ordinary methods, the brake does not operate if the wheels stand still, the very essential of the braking operation requiring the wheels to turn. It is a well-known fact that the most effective brakework is when the wheels do not skid upon the track, but when they are turning under the pressure of the brake; and contrary to the ordinary braking practice the energy of the electric train, instead of being thrown away in the form of heat and using up our wheels and brakeshoes, can be made useful in the propulsion of other trains. I have tried this method of braking with such a degree of refinement that a heavily-loaded car would creep on a down grade at a pace so slow that an egg could be put under the wheels and cracked and removed before the wheel would pass over it.

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[*] Abstracted from a paper read before the Convention of the National Electric Light Association at Kansas City.

Having thus touched upon the characteristics such as I would propose for a railway system of this kind, let us resume the consideration of our proposed line between New York and Philadelphia, and try to form some idea of the electrical pressure which would be required, the service which could be demanded, the number of cars which could be handled, the speeds which could be maintained, and the number of stations which would be required to operate the stations. We will assume for the purpose of this investigation an overhead conductor in the form of a solid rod 1in. in diameter over each track, or, if you please, a smaller rod over each track and a main conductor making up the equivalent capacity proposed, and a track of equivalent capacity. I take this arbitrary size because it is convenient for the purposes of our calculations, and because it falls well within the limit of expenditure which such a system would warrant. For instance, the American Bell Telephone Company has a line of long-distance telephone wires rounding from New York to Boston, a distance of about 300 miles, nearly three and a half times the distance which we are considering. On these poles are about 70 wires, each of No. 12 copper. The aggregate area of these conductors is over 800,000 circular mills, and the total weight of copper on this line, which is used simply for telephonic purposes, is about 40 per cent. more than the weight of two copper rods an inch in diameter running from New York to Philadelphia. If the investment is a reasonable one in the telephone system, cannot we certainly consider it a reasonable one in that larger field of the transmission of power of which we are now speaking?

As I have stated, of the number of trains which in 13 hours leave Jersey City for Philadelphia, 12 usually make only one or two stops. Allowing 60 cars, this would be about one car every 13 minutes. This interval of 13 minutes is nearly as short as would be desirable between cars running at an average speed of a mile a minute, no matter how perfect the block system, and it would be necessary, possibly, to run these cars in double-car units. We will assume for our purposes the size of a car such as is used on the elevated road of Brooklyn Bridge in New York, which would, with motor and passengers, weigh from 20 to 25 tons, or a total of, say, 50 tons for our unit. The formula to determine the size of conductor for a single transmission of car is

$$\text{C M}=\frac{15666\,n\,l}{e\,v\,p}$$

where n = the number of horse-power, l the distance in feet, E the potential at the motor, v the fall in potential, and p the commercial efficiency of the motor. If we assume the station situated in the middle of the line—that is, at the best point—and the work divided equally at the middle section on each side, then L being the length of line we have the formula:

$$\text{C M}=\frac{1566\,\text{N L}}{4\,e\,r\,p}.$$

This will be practically the same if the work is distributed over the entire line.

If more than one station is used, then the formula will become

$$\text{M}=\frac{15666\,m\,\text{L}}{4\,\text{E}\,v\,f\,5^0}.$$

that is, the size of the conductor would vary inversely as the square of the number of stations, if properly distributed. V may be expressed as a fraction of E, and for practical purposes we will let V = 1·9 of E and P such that

$$\frac{15666}{\text{P}}=16800,$$

that is, P = about 93 per cent. Then we have

$$\text{C M}=\frac{37800\,n\,\text{L}}{\text{E}^2\,\text{S}^2},$$

which may be expressed thus, that the size of the wire varies inversely as the square of the product of the number of stations and the E.M.F.

We may also note that with any fixed size of conductor the E.M.F. and the number of stations vary inversely, a somewhat important fact to remember.

We have another formula, one for the power required by a moving car, which is

$$\text{H.P.}=\frac{4}{75}\,w\,m\left(c+\frac{t}{20}\right),$$

where w = the weight in net tons, m the miles per hour, c the percentage of grade expressed as a whole number, and t the traction in pounds per net ton.

As I have stated, we will assume in this formula that c equals zero, a consideration in which I am justified in express service on a road of the character I have outlined, with the relation of grades and traction given, and with the method of braking I have described. Our formula would then become, using 10lb. per ton as our average traction,

$$\text{H.P.}=\frac{2}{75}\,w\,m,$$

which, substituted for n in the distribution formula, gives us

$$\text{C M}=\frac{1008\,w\,m\,\text{L}}{\text{E}^2\,\text{S}^2},$$

or substituting for L, 5280 d, d being the number of miles between stations,

$$\text{C M}=\frac{5322240\,w\,m\,\text{L}}{\text{E}^2\,\text{S}^2}.$$

We have assumed for our conductors two rods an inch in diameter, and that the rail has the same resistance. Hence substituting for C M its value 2,000,000, we have

$$\text{E}=\frac{2{\cdot}66112\,w\,m\,d}{\text{S}^2},$$

or

$$\text{E}=\frac{1{\cdot}631}{\text{S}}\sqrt{w\,m\,d}.$$

It will be noted that m, w, and d, that is, number of miles per hour, weight handled, and distance over which operated, are all affected in the same way. Hence, with any value of E and S we can vary the relative values of w, m, and d, so long as we do not disturb the product. That is, we can halve the number of miles and double the speed, or double the distance and halve the running speed, keeping the weight hauled the same, and so on. For the total weight we can substitute the weight of each unit, c, and the number of units, b, thus making the formula

$$\text{E}=\frac{1{\cdot}631}{\text{S}}\sqrt{m\,b\,c\,d}.$$

For the line proposed $d=90$, and we have

$$\text{E}=\frac{15.56}{\text{S}}\sqrt{m\,b\,c}$$

Taking our unit of two cars of 50 tons, the time intervals between them as 10 minutes, and 60 miles per hour as the mean speed, we have on the whole system 18 active units of two cars each, and $m\,b\,c=54000$, which substituted in our formula is

$$e=\frac{3616}{\text{S}}$$

which means that with one station in the middle the potential at the motor farther from the station would be 3,616 volts, and near the station one-ninth higher. Can we handle it? Yes, in time, but perhaps not yet. Nor is there any necessity for doing so; for, if we increase the number of stations and go to a three-wire instead of a two-wire system, making the track the balance circuit, we would have motor potential as expressed by the following table:

Stations.		Motor potential.	
Number.	Miles apart.	2-wire.	3-wire.
1	—	3,616	1,808
2	45	1,808	904
3	30	1,205	603
4	22½	904	452

which last brings us down to ordinary street car practice, which is only the beginning of what will be done in the effective handling of potentials.

So, after all, it does not seem such a serious electrical problem, and certainly not one to shrink from.

We can in another way illustrate the influence of the position and number of stations and the potential used.

Suppose we had a station at Jersey City to supply the entire line as a certain potential over a conductor of the required size. If the station be moved to the centre, the weight of copper necessary is only one quarter. Use two stations properly spaced and the weight is quartered again. Double the potential and the weight is further quartered. Now use the three-wire system and the weight is again quartered. So that, by these very simple processes, the original weight has been reduced $\frac{1}{256}$th of the original.

I do not think I need to point out further the value of a proper determination of electrical values in a problem of this character.

We see, then, that the suppositious case is well within the range of possibilities. A 60-mile express service every 10 minutes, instead of 40 to a 45 mile service every hour, would revolutionise travel. Of the comforts of such a mode of travel, I need not speak. That it will in the not very distant future be a fact, I know you all agree with me in hoping for.

SOME POINTS IN DYNAMO AND MOTOR DESIGN.*

BY W. B. ESSON, MEMBER.

(Continued from page 176.)

4. RATIO OF ARMATURE SECTION TO FIELD-MAGNET SECTION.

In the early days of dynamo designing the cross-section of the armature core in cylinder machines was very small in proportion to that of the field-magnets, the copper in the armature was excessive, and the air gap correspondingly great. The result was an induction no greater than in modern machines, but an enormous stray field. In the machines made by my firm six years ago, the section of the armature core was about one-third of the section of the magnets, the latter being of wrought iron. I may say these machines anticipated Mr. Swinburne's latest notions, inasmuch as the 14in. armatures of those days were loaded to 25,000 ampere-turns. The first great improvement consisted in doubling the iron and halving the copper, a machine so modified giving about the same output, but with less heating and less sparking, and requiring less magnetising force. We got the same output for two reasons: first, the decreased magnetic resistance resulted in an increased total induction; secondly, of this induction a far higher proportion was utilised. The ratio of the armature section to the magnet section, when modified as above, stood at ·66; but we went much beyond this in increasing the iron in the armature, finding that we obtained for every increase, keeping the air gap the same, an increase in the induction. The latter was not, of course, in proportion, but it was still very considerable, as will be realised from the fact that in an armature having a ratio of ·75 the induction was 10 per cent. greater than in one having ·6. When Mr. Kapp read his paper here on "Characteristics,"† I mentioned that then the ratio in our dynamos stood at ·75. Since then we have, in machines for incandescence lighting, returned to ·6, for a reason which will be by-and-by apparent. It may be mentioned here that when the magnets are of cast iron the ratio is ·33, while the cast-iron yokes for wrought-iron magnets are from two to two and a half times the area of the wrought iron.

I bring this forward because it is of some importance when the aim is to construct dynamos having a large output for their weight. The weight of the armature is only a fraction of the total weight of the machine. The field-magnets are many times heavier, but besides these the bed-plate, bearings, etc., make up a large portion of the weight, and since the weight of neither magnets nor bed-plate is increased by an increased armature section, manifestly, if a large output for the weight is the object, and if nothing occurred to interfere with the process, the cross-section ought to be increased to such dimensions that for any further increase to the total weight of the machine we get no corresponding advantage.

Some interesting experiments to determine this point, which completely corroborate my own, were made by Mr. Dugald Jackson, of Cornell University, and communicated by him in 1887 to the American Institute of Electrical Engineers.* These experiments can be consulted by those interested: for the present my remarks are based on the results obtained. Assume that the iron core of a cylinder armature having a ratio of ·6 is one-tenth of the total weight of the machine; then, by increasing the ratio to ·75 — that is, roughly, increasing the weight by 25 per cent.—we make an increase in the total weight of 2·5 per cent. But the increase in the induction will be about 10 per cent., so that clearly an advantage has been gained by increasing the section. If we increase the mass of the armature core by 50 per cent., it makes 5 per cent. increase in the total weight, but we get 15 per cent. increase in the induction. If we go farther we shall still get an increase, but it gets correspondingly less with each addition to the weight. The actual increase may not be in all cases in the proportion I have given. Necessarily it depends upon the design of the machine, but in the particular dynamo to which my remarks refer the results were as stated, and what I wish to point out is that in light-weight dynamos the armature must have a comparatively large section, and be worked at a lower saturation. Though the output for the armature weight is less, the output for the total weight is greater.

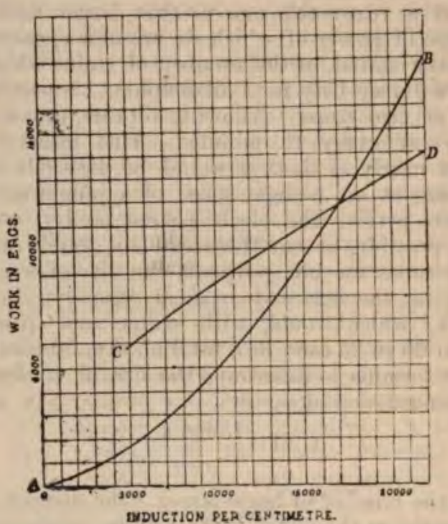

FIG. 14.

There is a limit to increasing the cross-section of the armature, which is reached when self-induction troubles us by creating a tendency to sparking, and cross induction troubles us from the diminished saturation of the core. Accordingly the practical limit in this direction is fixed for us at about ·75, and the induction at 14,500 or 15,000 C.G.S. per square centimetre. It must not be forgotten that increasing the section of the core increases the length of the wire on it by a small percentage.

Pressing the induction up to high values is not advisable, as the magnetism then costs too much. It will be seen from the curve, Fig. 1, that the magnetising force to produce an induction of 18,000 per square centimetre is about twice, while the magnetising force for 20,000 is more than six times that required for 17,000. As the core saturation is increased the stray field is increased, while the heating due to hysteresis is also greater. Everything considered, 17,000 per square centimetre is probably the best degree of saturation to employ for cylinder armatures, and makers who once employed a greater induction are, I believe, coming down to this. If we work lower we get on the bend of the curve or on that part where the angle changes rapidly; so that it is not possible to obtain in compound machines with a lower induction such perfect regulation. It may be mentioned in passing that, since the loss of potential in the armature and series winding is generally in slow-speed machines a higher proportion of the E.M.F., in these the difference in the induction on open circuit and at full load is proportionally greater, and the compounding, in consequence, less perfect.

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* Paper read before the Institution of Electrical Engineers, Feb. 20, 1890.

† Nov. 11, 1886. (See *Jour. Soc. Tel. Eng.*, vol. xv., p. 548.)

* *Electrical Review*, vol. xx., page 573, 1887.

There is no particular advantage in reducing the induction, save that of obtaining a higher weight efficiency. The reduction of the loss due to hysteresis is very small, and less than might at first sight be imagined. In Fig. 14 is given a curve, A B, showing the energy in ergs required to carry a cubic centimetre of iron through a complete cycle of magnetisation at different degrees of saturation. Induction per square centimetre is measured by abscissæ, and the energy by ordinates. It will be observed that for 17,000 the energy is greater by about 24 per cent. than for 15,000; but for an armature of given output the cross-section of the core has to be increased in proportion as the induction is diminished, and the total work expended in carrying the armature through a cycle of magnetisation is, roughly, proportional to the ordinates of the curve C D. To draw this curve an induction of 17,000 is taken as the normal, and all the ordinates of A B multiplied by the ratio of 17,000 to the induction. It will be observed that for any specified output there is only about 8 per cent. more power wasted in hysteresis at an induction of 17,000 than at 15,000.

In four-pole machines it is usual to saturate the armature to a lower degree—about 14,000—and in alternators the induction is still less—about 6,000. As the curve A B gives energy in ergs, the watts expended in the armature are found by multiplying this by the number of cycles per second and by the number of cubic centimetres in the armature, and dividing the product by 10^7. In drum machines the induction per square centimetre is rather over half of the value given for cylinders, and the ratio of armature to field section varies from ·8 to 1·0. The diameter of the armature being fixed with reference to the number and size of conductors, there is nothing to be gained by cutting away the interior of the washers. On the contrary, by cutting an opening only large enough for the shaft, the induction is kept low, and the magnetising force for the armature correspondingly small, while the heat generated due to hysteresis is also diminished.

5. INTERFERENCE OF THE ARMATURE FIELD.

Though iron may vary in quality, and so upset occasionally our calculations, no great difficulty need be experienced in approximating pretty closely the magnetising force required for a given induction in the armature core. But when we allow a current to flow in the coils, and so magnetise the core, we superpose on the original a second field and the interference between them renders the case no longer simple. If we excite the field-magnets of a dynamo with a constant current, and allow currents of various magnitudes to flow through the armature, we find on maintaining the speed uniform that the E.M.F. falls as the current is increased. In 1884* some investigations of mine were published which dealt with this question, and established the result that when the ampere-turns on the armature were few, and the field strong, the fall of E.M.F. with a fixed lead was about proportional to the current. As the field was weakened, the line representing the E.M.F. began to bend, until, when it was very weak, a kind of inverse characteristic was obtained, as shown in Fig. 15. In fact, the results are similar to those which would be obtained by reducing the winding on the magnets; the effect due to this being small when the magnets are fairly saturated, and large when they are far from saturation. It was then observed that the Hefner von Alteneck winding produced least weakening effect on the field, while the now defunct Bürgin produced most, the Gramme taking a position between these two. Since that date electricians have talked frequently of the weakening effect on the magnets of the current flowing in the armature; but though it is admitted that the induction is the resultant of the magnetising forces both on magnets and armature, the conditions determining this resultant are by no means clearly comprehended.

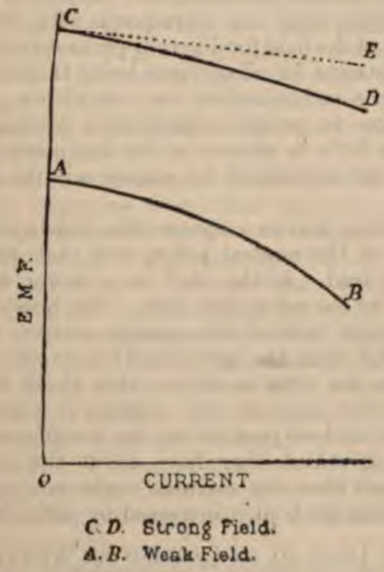

FIG. 15.

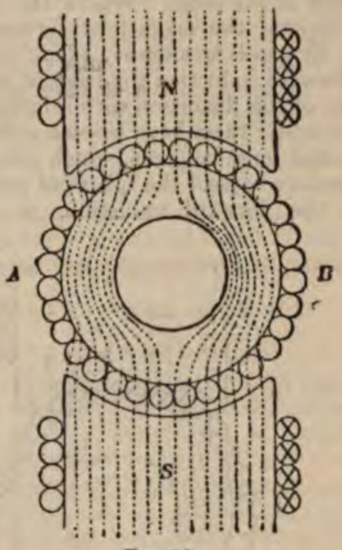

FIG. 16.

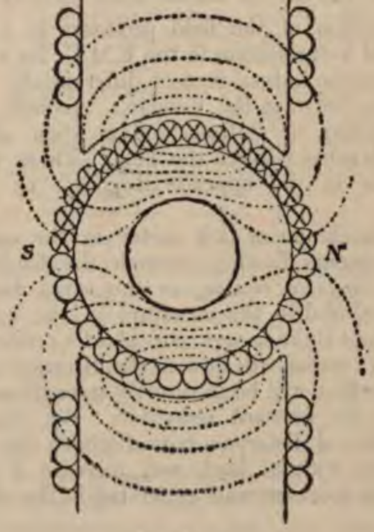

FIG. 17.

Consider the magnetic system shown in Fig. 16. N and S are the north and south poles of a field-magnet, the magnetising currents flowing into and out of the paper as shown by the open and crossed circles respectively. There is no current flowing in the armature coils, and the lines of force flow from pole to pole through the core as indicated by the dotted lines. Imagine that the current flowing round the magnet is stopped, and that a couple of brushes placed on the collector at S N, Fig. 17, cause a current to flow through the armature winding alone. We have the lines along paths indicated by the dotted lines, and obviously through this circuit at right angles to the other the cross induction depends, for a given number of ampere-turns, mainly upon the length and cross-section of the air gap. If we place the brushes at right angles to this position, we have no cross induction, but, instead, an induction taking the same path as the forward induction, though in an opposite direction. If the current is allowed to flow through field and armature coils at the same time, as it does in actual machines, we have the distribution of field as sketched in Fig. 18, the lines of force due to the magnets being pushed towards the left-hand top corner and right-hand bottom corner of the poles. Where the armature or cross induction opposes the magnet or forward induction, the field in the air gap is weakened; where the cross induction helps the forward induction the field is strengthened. In consequence of this distortion with reference to the brushes, the sections under them have become active, and to avoid sparking a lead must be given, which will remove the commutated sections beyond the sphere of activity. This lead diminishes the forward induction, at the same time diminishing the distortion with reference to the new position of the brushes.

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* "The E.M.F. of Dynamo Machines Excited by a Constant Current," *Electrical Review*, vol. xiv., page 303, 1884.

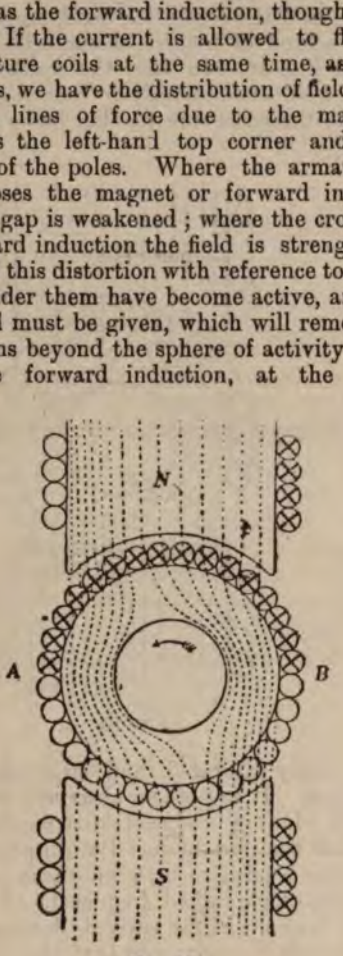

FIG. 18.

6. THE EFFECT OF DISTORTION ON THE E.M.F.

The distortion of the field produces in a dynamo run without lead a diminution in the E.M.F., for two reasons—first, because the induction acts differentially on the conductors lying between the brushes; secondly, because the currents flowing in sections active when short-circuited under the brushes weaken the field. These local currents induce lines in the opposite direction to the forward induction.

Let the machine run as a motor in the opposite direction, the currents flowing through the field-magnets and armature being, of course, in the same direction. The E.M.F. is induced in the armature in the opposite direction, and since in an active coil short-circuited under the brushes the current will flow in the direction of the induced E.M.F., its effect will be to directly strengthen the field as it increases the forward induction. We may say, then, that the effect of distortion is to diminish the E.M.F. in a dynamo run without lead, and increase it in a motor, owing to the local currents generated in the short-circuited coils.

The difference in the E.M.F. of a machine run without lead as dynamo and motor may be considerable, as shown by Prof. Ayrton's experiments at the beginning of last year. These experiments were made on a drum machine which had a comparatively weak field. I am not quite certain as to whether the cause here given is sufficient to account for the difference, but I believe that were the brushes adjusted in each case until the local currents were annihilated, the same E.M.F. would be, with properly laminated armatures, generated by both dynamo and motor. That there is a certain amount of power wasted in these currents is quite obvious, though from their tendency to lessen the distortion in the motor, their magnitude, and the consequent waste, is in the motor less.

7. POSITION OF THE BRUSHES IN DYNAMOS AND MOTORS.

If dynamos are to run sparklessly there must be a lead given to the brushes, or, in other words, the point of collection must be advanced in the direction of motion until the field passing through the commutated sections is just of sufficient strength to stop the current, reverse it, and bring it to its normal strength in the opposite direction before the section leaves the brush. When a section is short-circuited under the brush, any lines of force which were induced due to the current flowing in it are annihilated, the current tending by self-induction to continue in the same direction round the short circuit. As the section leaves the brush a current has to be started in it in the opposite direction, and the self-induced E.M.F. opposes this also, thus tending to prevent both the stopping and the starting of the current.

The E.M.F. of self-induction depends obviously upon the variation in the number of lines through the section which the cessation of the current is capable of producing on the speed of the armature, and on the number of turns per section. When an armature core is saturated to 17,000 per square centimetre, it will be realised that the variation in the lines through the section which the short-circuiting is capable of producing is very small, in fact, we may say that it is practically negligible. But with the smallest amount of self-induction present it takes a certain time to effect these changes in the section, and the brush must be of such thickness that the changes are effected before the short circuit is removed. The brush must be placed in advance of the neutral point: in an armature, for instance, having 50 sections, presuming that 5 volts are wasted in the armature, a section when it leaves the brush must move in a field having such strength as will neutralise the effect of self-induction, and give one-fifth of a volt over. If the armature has 100 sections, the field must give a resultant of one-tenth of a volt; but the E.M.F. due to self-induction will be in the latter case only one-fourth of what it was in the former. By saturating the core, and making the sections sufficiently numerous, we can make the self-induction as small as we please; and in machines in which the current varies from 0 to a maximum, we purposely make it as small as possible. The reason is that as the current increases, the variation in the E.M.F. of self-induction does not correspond with the variation in the shape of the field for different positions of the brushes, perfect adjustment for all currents being therefore difficult. By making the self-induction very small we get a close approximation to perfect adjustment; we can place the brushes very little in advance of the zero position, reducing in this way the adjustment for variation in the current to a minimum.

We see, then, that in a dynamo the brushes must be set in advance of the neutral point, and that self-induction increases the lead. Is the trail in a motor similarly increased? The answer is that it is. The brushes must be set in a motor behind the neutral position so that the induced E.M.F. is in the same direction as the current to be started in the section, and so that the E.M.F. of self-induction which opposes the starting is neutralised. It appears that the best position for the brushes in a motor is the position in which they have about the same trail as they have lead when the machine works as a dynamo, and that in a motor the trail is increased by self-induction.

8. THE LOAD TO BE CARRIED BY ARMATURES.

Assuming that a machine is properly designed, a position can be found for the brushes where the sparking is nil. If, on the other hand, the machine is badly designed, or if the current carried by the armature is too great, a sparkless collection will be found impossible, from the excessive distortion produced by the armature field. There is for every machine a certain limiting number of ampere-turns which the armature can carry, beyond which we cannot go without effecting some radical alteration in the design.

Now it is manifestly of the very greatest importance to know to what extent an armature can be loaded for a given field. It will be understood that the cross induction—that is, the lines of force which can be induced by the armature winding—depends upon the number of ampere-turns on the armature, and upon the magnetic resistances of the various parts which make up the cross circuit. Undoubtedly the induction follows the same law for the cross as for the forward circuit, though it is difficult to determine with accuracy either its magnitude or direction. But we know that by far the largest portion of the resistance is encountered in the air gap, and that increasing the length of the gap diminishes almost in inverse ratio the cross induction. We know also that the cross induction depends on the width of the air gap, for the greater the cross-section of the gap, the greater the cross induction for a given cross-section of armature core and a given magnetising force. It depends also, but to a less extent, on the induction in the core.

The forward induction we can give to a machine may be considered as proportional to the cross-section of the armature core; for if the magnets are large enough, with sufficient magnetising force, we can always in normal types get an induction of 16,000 to 17,000 C.G.S. per square centimetre.

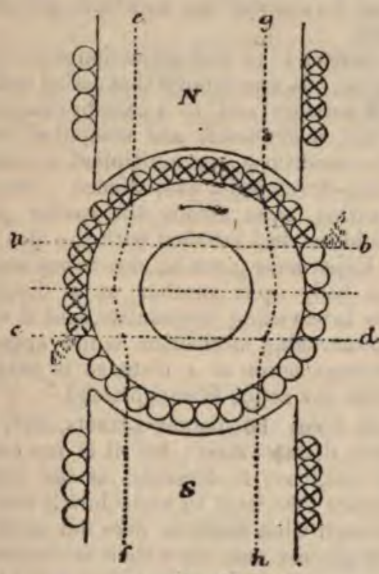

Fig. 19.

Now the distortion of the field depends upon the ratio of the cross to the forward induction. In actual machines we have not, of course, two sets of lines crossing each other, but the tendency to produce a cross induction is manifested in a distortion produced in the forward lines. It is to prevent the sparking which would ensue, due to this distortion, that a lead is given.

The cross induction may be reduced in double-magnet machines by thinning down the magnets, as shown in Fig. 3. This illustrates a type of magnet I designed in 1884, which gave first-class results, to the great surprise of many who believed that no good effects could be obtained without massive pole-pieces, irrespective of the configuration of the magnetic circuit otherwise. For the reasons given in section 3, it is undesirable to reduce the section of single-magnet machines with this object. Another plan for reducing cross induction is in making the air gap increase from the crown of the poles towards the tips, as was done by Messrs. Paterson and Cooper in the Lumley machines before I joined them, and as is done in some of the Manchester machines for another purpose.

As both forward and cross induction are proportional to the length of the armature, we need not consider that dimension here, but simply confine ourselves to the cross-section of the armature and poles as shown by the several drawings. A lead being given to the brushes, it will be observed that the convolutions lying between the two horizontal lines, *a b* and *c d*, Fig. 19, directly opposed the forward induction along *e f* and *g h* since the current flows in them in the opposite direction to the current round the magnets. The lines of force which would be sent in an opposite direction may be called the backward induction. This *per se* is of little consequence, as it can be compensated by additional turns on the magnets, but the distortion of the field to which its existence is due is of enormous importance.

It is not my intention to take up time with any calculations respecting the actual number of cross lines which would be induced by the current flowing in the armature, or to try and map out the exact distribution of the field as modified by cross induction. For the present I will be content with the statement—which is, of course, open to criticism—that, roughly, the cross induction is proportional to the ampere-turns on the armature and to the width of the poles, measured parallel to the direction of rotation, and inversely proportional to the length of the air gap—*i.e.*, the distance between the polar surface and the surface of the armature core. Calling A_2 the ampere-turns on the armature, w the width of the air gap, and l its length, the tendency to induce cross lines is measured by $\frac{A_2 w}{l}$; and since the forward induction is proportional to the radial depth of the core, r, for all sizes of machines, the ratio between the above value and r should be similar. In other word, the ampere-turns which can be carried by the armature are proportional to the radial depth of the core and to the length of the air gap, and inversely as the width of the pole, whence

$$A_2 \propto \frac{r\,l}{w}.$$

For the purpose of showing to what extent some such relation as exhibited obtains in the machines now made, I have given in Table II. the dimensions of several taken at random.

Table II.—*Loads Carried by Cylinder Armatures.*

Name of machine.	I. Outside diam. of arm. core.	II. Ampere-turns on the armature.	III. Radial depth of the core.	IV. Angle embraced by each pole.	V. Length of the air gap.	VI. Width of the pole-piece.	VII. Coefficient.
Dynamos.				Deg.			
1. Gramme ..	18·3	6,000	2·65	135	0·85	23·0	61,265
2. Phœnix	22·2	6,500	2·85	115	0·80	24·0	68,421
3. Phœnix	27·0	9,000	3·35	112	0·96	28·5	79,757
4. Crompton ..	18·3	7,560	3·80	135	0·96	23·5	48,700
5. Manchester .	24·1	10,500	5·05	139	0·80	31·0	80,569
6. Phœnix	33·0	13,500	5·10	115	1·10	35·5	85,427
7. Kapp	33·0	13,020	5·30	140	1·25	43·0	84,507
8. Phœnix	35·5	18,000	6·35	122	1·20	40·6	95,905
9. Kapp	36 8	13,875	6·10	140	1·25	48·0	87,344
10. Crompton ...	39·35	26,400	7·94	135	1·95	51·0	86,959
11. Phœnix	43·0	23,000	8·90	115	1·27	44·2	89,940
12. Phœnix	42·6	17,100	7·30	120	1·27	47·0	86,689
Motors.							
13. Immisch ...	30·4	9,000	6·40	{120 130}	0·96	35·2	51,562
14. Immisch ...	38·0	15,000	7·60	{120 130}	0·96	43·5	89,432
15. Immisch ...	61·0	27,300	11·40	{120 130}	1·63	70·0	102840

In the first column after the names of the dynamos comes the outside diameter of the armature core, which does not enter into our expression. Next come the ampere-turns carried, followed by the radial depth in centimetres, with both of which we have to do. In column iv. is given the angle in degrees embraced by each pole, while columns v. and vi. give the length of the air gap and width of the pole. In column vii. is given a coefficient by which the right-hand side of the equation must be multiplied, in order that for the sign of proportionality we can in each case substitute equality. According to the proposition put forward this coefficient ought to have the same value in all cases. The agreement is marvellous when we remember that in machines of the same size we have to vary the load considerably to suit different outputs, and that in the examples given the saturation may vary considerably. The disturbance due to cross induction bears about the same proportion in all; the similarity in this respect being, in fact, remarkable for machines so dissimilar otherwise. The machines Nos. 7 and 9 have iron wire cores, but Mr. Kapp has kindly given me the equivalent dimension of the radial depth were plates employed instead, and this is what appears in column iii. The machine No. 4 is given because it is the one which departs most from my equation. The ampere-turns on the armature are here so few—that is to say, there is so little copper and so much iron—that I at one time suspected it of being the very machine which Mr. Crompton confesses to having designed during Mr. Kapp's absence at Vienna. In the machine No. 8 the coefficient has been since reduced by shortening the poles. About the motors Nos. 13, 14, and 15 I shall have something to say presently. In these the edges of the poles are curved along their lengths, hence the two angles in column iv. The coefficient is calculated from the mean width.

Inserting what appears to be the mean value in column vii., we have for the ampere-turns which may be carried by an armature the expression,

$$A_2 = \frac{r \; l \; 85{,}000}{w},$$

which may prove very useful until we get something more exact. We have been taught by experience that diminishing the ampere-turns, increasing the radial depth, increasing the air gap, or diminishing the width of the poles, reduces the distortion and cures its attendant evil of sparking. The equation states the same thing in another way, for it tells us that the ampere-turns may be increased in proportion to the radial depth and to the length of the air gap, and inversely as the width of the poles. I do not wish for a moment to dogmatise on this subject. It is not pretended that the expression is complete, as there are doubtless many factors upon which the load depends. Amongst these are, obviously, the number of sections of the armature, the shaping of the pole-pieces, and the general configuration of the magnetic circuit. But the equation is at least a guide, and if the coefficient 85,000 is not exceeded, the machine can certainly be made to run without sparking. The expression applies equally to armatures with more than two poles, only in the case of these the ampere-turns given by it must be multiplied by the number of pairs of poles.

When speaking of the radial depth being increased it is of course assumed that there is the same induction per square centimetre in the increased section of the core. Again, increasing the air gap is not supposed to diminish the induction, as additional magnetising force must be provided to keep it up to its original value. We conclude, then, that if the output of a machine of given carcase dimensions is to be increased, or, in other words, if the ampere-turns on the armature are to be greater, the tendency to increased cross induction must be counteracted by increasing the resistance of the air gap. Some will doubtless be astonished to hear that greater output necessitates increased magnetic resistance.

Mr. Ravenshaw has a rule to the effect that in order to prevent sparking in cylinder armatures the ampere-turns must not exceed 35 times the total area of the core in centimetres or in drum armatures, assuming the same induction per square centimetre, 70 times the area. The rule has been applied to the construction of several types of two and four-pole machines, but it does not seem to me universally applicable, since the number of ampere-turns allowable depends not only on the area but on the relation of the two factors which make up the area.

Practical men must have rules of some kind. Without them their practice could not be continued for a single day. These rules, written or unwritten, are the results of experience which have been aggregated into some kind of applicable shape, but justification for which it would often be difficult to find on purely scientific grounds. We have to make our rules as we go along, engineering intuition and empiricism leading the way, knowledge and scientific accuracy following. We can speak with authority regarding the utility of a formula which we would be ill-prepared to justify scientifically. It is because the rule here given has proved useful to me that I venture to suggest its use to others.

(To be continued.)

A REVIEW OF MODERN ELECTRICAL THEORIES.*

BY PROF. WM. A. ANTHONY.

The general phenomena of electricity are familiar to us all. As children we learned of the attraction and repulsion of electrostatic charges, of condensers, of insulators and conductors, of electric currents and electromagnets of telegraphs, of electric fire alarms and electric bells, of the heating of conductors, and even electric lights. We have long been familiar with the effect of the current on a magnetic needle, and with the attraction and repulsion of currents for each other. We have seen that these effects are manifested at a distance from the conductors which carry the currents, and we have been willing to believe that the distances at which these phenomena could be recognised were limited only by the want of sensitiveness of the apparatus through which the effects were manifested. Probably not many of us stopped to think how these effects were brought about. We were content with a general statement of the relations of the phenomena, or, at least, with the determination of the direction and intensity of the forces due to a given conformation of current. We talked of the attractions and repulsions as action across space, and if we thought of them at all as requiring any mechanism through which to act, we still felt satisfied when we had discovered and formulated the laws that govern the action of these forces.

It did not matter to us that attraction across empty space was unthinkable. It was enough that action took place, and that we could measure and, to a certain extent, control it. We constructed instruments and computed forces acting under certain conditions, we multiplied experiments and thought we had developed a vast science. But there have not been wanting, even among the earlier philosophers, some who could not feel satisfied with the idea of action at a distance. Experience gives no clue to any explanation of action of one body upon another at a distance, except through some intervening mechanism, and if we find cases where such intervening mechanism is not apparent, to say that in these cases action at a distance is taking place is only to say that the action is unexplained.

Gravity acts upon the distant planets, and, we believe, upon the most distant stars; but it is not enough to say that gravity acts, that it decreases as the square of the distance increases; we want to know how it acts. By what means, or through what medium, does our earth reach out to the distant planets and affect their movements? These are the questions that the dissatisfied few have asked in the past, and to-day it is not the few but the many who would be glad to have the question answered. Faraday early taught us that the mere statement of the law of electrical attraction or repulsion was no explanation, and he sought the explanation in the action in the intervening medium. He demonstrated, by experiments that have become classic, that the effect of induction depends upon the nature of the medium intervening between the conductors; a demonstration that here, at least, the intervening medium took part in the action and helped to determine the result. Magnetic and electromagnetic phenomena were to Faraday also effects propagated through the medium; and Maxwell, following Faraday's work, subjected the whole matter to a searching mathematical analysis. It was necessary, in order to complete the theory, to assume the existence of a medium in which the forces were exerted; but, as a medium had already been assumed to account for the phenomena of light, it would hardly be scientific to assume another to account for electrical phenomena. But would not one medium suffice for electrical and optical phenomena as well? Maxwell showed how the question of the identity of the two media could be tested, and our modern views of electricity are mainly the results of his work. What do we know of electrical phenomena? We know that pieces of glass and silk rubbed together and then separated attract each other; that the property of attraction can be imparted to metals if they are insulated; that if two such masses of metal be connected by a wire the power of attracting each other disappears, and, at the same time, the wire is warmed and for an instant exerts magnetic forces at right angles with the wire. Numerous other facts we know, but these will suffice as illustrations of the phenomena. When a metal conductor is discharged by touching it with a wire we say the wire carries a current, and we have been accustomed to ascribe the heating and the magnetic effects to that current. We have looked upon the thing, whatever it is, that takes place in the wire as the origin of all that takes place around it.

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*Paper read before the American Institute of Electrical Engineers, New York, Jan. 21, 1890.

The current warms the wire, and it confers upon it the property of acting upon magnetic needles; but how does it act? We cannot conceive of the action of that wire on that needle, except through something extending from the wire to the needle through which the wire can exert a push or pull. All around that wire the needle is affected; at considerable distances the effect can be exhibited, and we believe it is only want of delicacy of our apparatus that prevents our discovering it at the greatest distances. If the wire acts, it acts through a medium in which it creates a disturbance, and the disturbance, in turn, acts upon the magnetic needle. But are we sure that the action begins with the wire? Is it not possible that the action begins in the medium, and that the wire merely separates portions of the medium, and so permits action that could not otherwise take place? Maxwell has proposed a mechanical illustration of the action taking place in space when electrical phenomena occur, and Fleming and Lodge have elaborated it and brought it within the reach of non-mathematical readers. Let us suppose all space to be filled with wheels connected by idle wheels in such a way that when one turns all must turn in the same direction, except that the elasticity of the system permits a small movement of one wheel before the others in the vicinity begin to move. E.M.F. is then something that tends to turn the wheels.

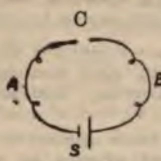

Fig. 1.

Let S, in Fig. 1, represent some source of E.M.F.; A and B conductors not forming a closed circuit but having an opening at C. The E.M.F. at S tends to turn the wheels, but so long as the gap exists at C the wheels are connected through all space, and the E.M.F. at S can effect nothing except to turn the wheels through a small angle until the elastic resistance balances the E.M.F. In the conductor the wheels are not supposed to be rigidly connected. They can turn by slipping on each other, and the wheels in space may turn by slipping on the wheels in the conductor; hence, as the ends of A and B approach each other, the connection between the wheels within the enclosure and those of outside space becomes smaller and smaller, and when the conductors touch there is no longer anything to prevent the wheels within from turning, and they begin to spin in obedience to the E.M.F. at S. The conductor is heated by the friction due to the slip of the wheels around and within it. The spinning of the wheels constitutes the magnetic forces if we assume the wheels, originally spherical, to become flattened spheroids by the spinning, and to be forced to remain in contact at their poles. Assume the wheels to have inertia, and it will require time for them to reach their full velocity, and the time will be greater as the number of wheels is greater, that is, as the magnetic forces developed are greater. On the other hand, the wheels will not at once stop if the E.M.F. is removed, and if the conductor be broken at some point, allowing the rapidly spinning wheels enclosed by it to come in gear at that point with the stationary outside wheels, there will be, for a brief time, until the moving wheels can be brought to rest, a clashing and disruptive action known as the extra spark.

I have spoken of the heating of the conductor as due simply to the friction of the spinning wheels upon the wheels within the conductor. The greater the friction the greater the motion imparted to the wheels within the conductors and the greater the heating. The less the friction the less the heat, and if there were a substance whose wheels could revolve among themselves and against the wheels of space without friction, such substance would form a perfect conductor which would offer no resistance to the motion of the wheels in the space enclosed by it, and however rapidly those wheels might revolve they would have no influence to produce motion within such a conductor. We are led, then, to this: that a perfect conductor, instead of being a substance in which any E.M.F. produces an infinite flow of electricity, may be a substance in which no effect whatever is produced.

I do not present this as representing the real activities involved in electrical phenomena, or as a theory by which all electrical phenomena may be explained. I give it as bringing prominently into view the activities in the medium surrounding the conductor, whereas the language in which we usually describe electrical phenomena points to the conductor itself as the seat of the electrical forces. Whatever our theory, we know that something does take place in the medium that surrounds the conductor. We know that were a heavy current to flow through a conductor in the most distant part of this room, a delicate needle here on the table would show that a magnetic field was produced here. We are certain that magnetic lines of force from the electric currents on our streets, whether overhead or underground, permeate this room, and traverse our bodies even, though we have no sense through which we can become directly conscious of them. Take in your hands two wires connected to the poles of a battery or dynamo and touch their ends together. You see a flash of light, the wires become warm, they attract iron filings; coiled into a spiral they will attract with great force large masses of iron; two such spirals will attract or repel one another. What more natural than to say, Here in the wire is a new activity which warms it and confers upon it magnetic properties? What more natural than to forget or fail altogether to recognise the activities in the space around?—activities that do not impress any of our senses; that do not wrench our arms, or burn our flesh, or blind our eyes; and yet it is well to fix our attention for a while upon the space that the conductor encloses, and recognise the fact which the little delicate needle demonstrates to us, that something is going on in that space, something quite as important, perhaps more important, than that which takes place in the conductor.

Whatever the magnetic forces are, we know they cannot be called into existence instantaneously. Time must always elapse before the full effect of an electric current is felt, and the greater the forces developed the longer are they in reaching the maximum. Moreover, the current in the wire cannot be at once developed, it keeps pace with the magnetic force, and reaches a maximum only when the magnetic forces reach a maximum. This is exactly what would follow if magnetic forces result from the setting in motion of wheels possessing inertia. Whatever magnetic forces may be, they begin and end like the motions of massive bodies.

(To be concluded.)

COMPANIES' MEETINGS.

TELEGRAPH CONSTRUCTION COMPANY.

The twenty-sixth ordinary general meeting of shareholders in the Telegraph Construction and Maintenance Company, Limited, was held on Tuesday at the offices of the Company, 38, Old Broad-street, E.C., Sir George Elliot, Bart., M.P., in the chair.

The **Managing Director** (Mr. Shuter) read the notice convening the meeting.

The **Chairman**, in moving the adoption of the report, made a feeling allusion to the great loss which the Company had sustained by the death of their chairman, the late Sir Daniel Gooch, under whose administration the Company had enjoyed an unbroken period of prosperity for so many years. He (the Chairman) had been induced to accede to the unanimous request of his colleagues that he would accept the position of Chairman of the Company, having been a Director since its formation, and 10 years previously he was an active partner in the business before it became the property of the Company. He had, therefore, as fair a knowledge of its working as any individual could have, and he took a keen interest in the property. The success which had attended the Company had been due in no small measure to the policy adopted by the Board from the first—namely, that of giving the shareholders every information they could reasonably desire, but at the same time maintaining due reticence with regard to business matters which, if made public, might seriously affect the Company's interests. As regarded the work of the past year, they had not much to complain of. Their profits had been largely due to the improvement of their general business over and above the submarine telegraph. This was very agreeable intelligence, because they had something else on which they could rely besides submarine telegraph work, and, so far as they were able to judge at this early period of the year, their prospects continued favourable. They had two contracts in hand, one of which was the large cable to be laid between Australia and New Zealand, which was now despatched, and they had to renew a portion of the Madras and Penang cable, which they should have to carry out next week. The Chairman concluded by moving the adoption of the report, and the declaration of a dividend at the rate of 15 per cent., making, with the interim dividend, 20 per cent. for the year.

Mr. George W. Campbell seconded the motion, which was carried unanimously.

The usual formal business was then transacted, and the proceedings terminated.

CITY NOTES.

Direct Spanish Company.—The receipts of this Company for February were £2,225, against £2,008.

West Coast of America Telegraph Company.—The receipts for the month of February amounted to £4,500.

Brazilian Submarine Telegraph Company.—The receipts for the week ended February 28 amounted to £5,025.

Eastern Extension Telegraph Company.—The traffic receipts for the month of February were £38,466, as against £37,584 for the same period of 1889.

Eastern Telegraph Company.—The traffic receipts for February were £53,347, as against £54,611 for the same period of 1889, or a decrease of £1,264.

Cuba Submarine Telegraph Company.—The estimated receipts for February were £3,300, against £3,204. The receipts for November, estimated at £3,000, realised £3,112.

Cuba Submarine Telegraph Company.—For the month of February the receipts of this Company show an increase of £96 as compared with the corresponding period.

West India and Panama Telegraph Company.—The estimated receipts for the half-month ended February 28 were £3,038, against £2,703. The November receipts, estimated at £5,930, realised £5,989.

Change of Address.—The United Asbestos Company, Limited, have removed from Queen Victoria-street to larger premises at Dock House, Billiter-street, E.C., lately in the occupation of the East and West India Dock Company.

Western and Brazilian Telegraph Company, Limited.—The receipts for the week ended February 28, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,858.

Brush Electrical Engineering Company.—The following circular has been issued by this Company to the shareholders : "Six months having elapsed on Feb. 10 since the registration of the Brush Electrical Engineering Company, Limited, the Directors have pleasure in stating that practically the reconstruction has been completed, and that the business of the Company is established on a satisfactory and permanent basis. The total amount of orders received by the Company is very satisfactory, and the prospects for the future are highly encouraging. The works of the Company in London, at Loughborough, and on the Continent are fully occupied, and the extensions of the Falcon Works at Loughborough are making rapid progress towards completion. The Directors have decided in view of the satisfactory volume of business transacted during the past six months, to pay a dividend on the preference shares, and warrants for an interim dividend on these shares at the rate of 6 per cent. per annum, from August 10, 1889 (the date of registration of the Company), to Feb. 10, 1890, are issued herewith. The books of the Company will not be made up until the close of the year, and the Directors reserve the question of a dividend on the ordinary shares until the complete accounts are before them."

PROVISIONAL PATENTS, 1890.

FEBRUARY 24.

2945. **Improvements in and relating to, and in the manufacture of electric secondary cells.** Arthur Maril François Laurent-Cély and Illius Augustus Timmis, 2, Great George-street, Westminster.

2957. **Improvements in electric meters.** Jean Jacques Auguste Aubert, 24, Southampton-buildings, London. (Complete specification.)

FEBRUARY 25.

2986. **Improvements in electric lamp sockets and devices attached thereto for regulating the light.** William Friedrich Wollin and Elmer Henry Werline, Birmingham. (Complete specification.)

2996. **Improvements in electric meters.** Roger Joseph Francis Mostyn, 30, Maitland-park-road, Haverstock Hill, London.

3008. **Improved storage or secondary batteries.** William Barnum Hollingshead, 55, Chancery-lane, London. (Complete specification.)

3013. **Improvements in storage or secondary batteries.** Charles James Hartmann, 18, Buckingham-street, London. (Complete specification.

3024. **Improvements in electric motors.** Henry Harris Lake, 45, Southampton-buildings, Middlesex. (Edward Benjamin Parkhurst, United States.) (Complete specification.)

3028. **Improvements in dynamo-electric and electro-dynamic machines.** Antoine Charles Reignier, 28, Southampton-buildings, London.

FEBRUARY 26.

3058. **An improved electric and tubular pneumatic action in organs, and in means of working the combination pistons of the same.** James Jepson Binns, 8, Quality-court, London. (Complete specification.)

3071. **An electric meter.** William Joseph Starkey Barber-Starkey, 28, Southampton-buildings, London.

3082. **An improvement in filaments for incandescent electric lamps.** Rudolf Langhans, 45, Southampton-buildings, London.

3094. **Improvements in portable electric lamps, more especially intended for miners' use.** The Mining and General Electric Lamp Company, Limited, Desmond Gerald FitzGerald, and Arthur Henry Hough, 47, Lincoln's-inn-fields, London.

3096. **Improvements in electric meters.** Sebastian Ziani de Ferranti, 24, Southampton-buildings, London.

3097. **Improvements in electric meters.** Sebastian Ziani de Ferranti, 24, Southampton-buildings, London.

FEBRUARY 27.

3133. **Improvements in or relating to electric lamps.** Frederick Richard Boardman, 433, Strand, London.

3152. **Improvements in the manufacture of electrical conductors.** William Arthur Thoms, 6, Bream's-buildings, Chancery-lane.

3153. **An improved mode of manufacturing electrical conductors.** William Arthur Thoms, 6, Bream's-buildings, Chancery-lane.

3163. **Improvements in electric switches.** Philip Pembroke Alexander, 24, Southampton-buildings, Chancery-lane.

FEBRUARY 28.

3193. **Improvements in and connected with transformers, electrical measuring instruments, and insulation.** James Swinburne, 49, Queen's-road, Wimbledon, Surrey.

3196. **Electrical and steam application for actuating separate and independent alarms in connection with valves.** Samuel Walker and George Mills, Radcliffe, Lancashire.

3231. **Automatically regulating and keeping constant the electromotive force or pressure of any electric circuit.** John Shipp, 59, New Broad-street, London.

MARCH 1.

3271. **Improvements in dynamo-electric machines.** Charles Newton Russell and Ronald Augustus Scott, 17, Heathfield-road, Mill Hill Park, London.

3272. **Improvements in switches for controlling electric circuits, especially electric light circuits.** George Edwin Fletcher, Chester House, Chatham-street, Edgeley, Stockport.

3276. **Improvements in telephonic apparatus.** Alfred Whalley, Helsby, near Warrington, Cheshire.

3304. **Improvements in apparatus for enabling a supply of gas or other fluid, or a current of electricity, to be obtained for a limited time on prepayment therefor.** Matthew Cranswick Greenhill, 47, Lincoln's-inn-fields, London.

SPECIFICATIONS PUBLISHED

1889.

5615. **Generating electricity on trains.** Timmis. 6d.
6021. **Dynamo-electric machines.** Shepard. 8d.
7138. **Electric glow lamps.** Fitch (Drummond). 6d.
7506. **Electrically lighting railway trains.** Timmis. 8d.
18018. **Electro-magnetic brakes.** Boult (Ries and another). 8d.
20261. **Railway electric semaphores.** Stitzel and others. 8d.
20911. **Storage batteries.** Woolf. 8d.
20971. **Electric exercising machine.** Imray (Electric Exercising Machine Company.) 8d.

1890.

272. **Electro-magnetic dispatch apparatus.** Haddan (Williams). 8d.
302. **Secondary batteries.** Lake (Alexander). 8d.
303. **Secondary batteries.** Lake (Alexander). 8d.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Anglo-American Brush	—	2⅝
— Pref.	—	1⅞
India Rubber, Gutta Percha & Telegraph Co.	10	18⅞
House-to-House	4½	5
Metropolitan Electric Supply	—	4½
London Electric Supply	5	3½
Swan United	3½	5¼
Telegraph Construction	12	45
— 6%, 1889	100	105
National Telephone	5	5¼

NOTES.

Algeria.—The plant for the lighting of Batna, Algeria, has been disembarked at Philippeville, and the central station for this town is being proceeded with as fast as possible.

Battery Bookcase.—The Parisian mansion of the Duc de la Tremoille is now lit up by electricity. The electricity is generated by cells which are made to appear like books in a shelf.

Long Mileage.—The East Cleveland Street Railroad Company, of Cleveland, Ohio, run their 40 electric cars an average total mileage of 5,000 miles per day, or an average per car of 125 miles a day.

Mansfield.—The town of Mansfield seems to have taken a step rearwards—it is to be lighted with twenty oil lamps. It will no doubt be in a good mood to accept the aid of electricity at the end of half a year.

Electric Welding.—The naval officers appointed by the United States Secretary of the Navy have visited the Thomson electric welding works at Lynn, to report upon its suitability for employment on the cruisers and men-of-war.

Journal.—We have received the *Journal* of the Institution of Electrical Engineers containing the president's address on "Magnetism" and discussion; and also abstract of a paper by Arthur E. Childs, B.Sc., on "Electric Traction as applied to Tramways."

Paris Telephones.—The complaints in regard to the Paris telphone system have induced the Minister of Post and Telegraphs to decide upon the erection of a large telephone exchange in the centre of Paris, with accommodation for 30,000 subscribers.

San Maritz.—The proprietors of the large hotels in the heights of San Maritz are occupied with the consideration of a project for the establishment of a central station to utilise 400 h.p. from the neighbouring river, which will be distributed to a distance of about three miles.

Rope Gearing.—It is a curious fact while rope gearing is somewhat on the increase in England, that the experience in Paris has not been in its favour. It seems that the rope gearing in the Halles Centrales has begun already to fray, though the Scellos belting shows not the least sign of way.

Berlin.—The large houses in the Kurfurstendamm, Berlin, are to have an electric central station of their own, at first supplying 1,000 incandescent lamps of 16 c.p., and 350 of 25 c.p., the latter being for street lighting. Eventually the installation will comprise 4,000 16-c.p. lamps and 1,000 of 25 c.p.

Private Stations.—Another private central electric light station has been erected in Paris in the Champs Elysées by the firm of Beau-Bertrand et Taillet. Like the Pulsford station in the Faubourg St. Martin, the cables do not encroach upon the public street, serving only the large block of houses in the neighbourhood.

Institution.—The next meeting of the Institution will be on Thursday, the 20th inst., when the discussion on the papers by Mr. Swinburne and Mr. Esson is to be finished. The next paper to be read will be on "Alternate *v.* Continuous Currents in relation to the Human Body," by H. Newman Lawrence, member, and Arthur Harries, M.D.

Printing Offices.—The chairman of Messrs. Cassell and Co. at their annual meeting said that the directors had under their consideration a scheme for the entire lighting of their offices by electricity. The advantages of electric light for printing offices is becoming thoroughly appreciated, and Messrs. Cassell's are not the only large house that are thinking about introducing the light.

South London Trams.—At the half yearly general meeting of the South London Tramways Company held on Friday at the City Terminus Hotel, the chairman, Mr. S. J. Wilde, alluded to the development which had lately taken place in electric traction in this country, and said he considered that the solution of the question of mechanical power on tramways would be found eventually in the adoption of electricity.

Strasburg.—The first German Catholic church to be lighted electrically is the Strasburg Cathedral. Arc lights have been used outside with grand effect, and inside with incandescent lamps disposed round the piers and columns. It was feared that the electric light would spoil the dim and religious effect. It is true that the piers are more brightly lighted, but the interior as a whole is stated to be highly satisfactory.

Niagara Falls.—The project to utilise the water-power of Niagara is stated to have been brought to a practical issue, and that work on the main tunnel will be soon commenced. The scheme is to take a tunnel 24ft. diameter, and about 2½ miles long, taking the water from above the falls and using it to drive turbines. The cost is given as 2¼ million dollars. An influential board of trustees are appointed.

Electrotechnology in Spain.—It is announced by *El Telegraphista Espagnol* that the Director of Telegraphs, with Dr. Celestino Goni, have founded a preparatory academy for the school of electrical engineers in Madrid. Mathematics, geometry, differential calculus will be taught to the pupils, as well as knowledge of electricity and mechanics, which will be carried on at the higher school. The terms are equal to £1 a month for all the classes.

Overhead Wires.—At the Wandsworth District Board the committee reported having considered the London Subways and Overhead Wires Bill. They agree with Westminster and Kensington Vestries that overhead wires should be removed and the powers should be vested in vestries and district boards. It was agreed to inform the Kensington Vestry that the Board do not consider it necessary to petition themselves, but will give all assistance in their power to the Kensington petition.

Post Office.—The whole of the order for making the main and branch distributing switch and fuse boards required for the electric light extension at the General Post Office has been obtained by the Acme Electric Works, with also a large order (upwards of 2,000) for "Cockburn's" patent fuseboxes and fuses for use throughout the same installation. Other heavy work is in hand by the same firm, together with some 30 large distributing-boards for leading firms, one of which is to control 5,000 lights.

Electric Clocks.—In a very complete paper upon "Recent Progress in British Watchmaking" before the Society of Arts, Mr. Julien Tripplin remarks that although in chronometry we are supreme, and in other branches have a decided lead, yet in the decorative style, in the application of electricity to clockmaking, and to the synchronising of clocks by electricity, the foreigner has a foremost place.

This he attributes to the widened mental condition coming from special training in the technical schools.

Astonishing the Natives.—An amusing account comes from New Guinea relating the effect upon the natives when the s.s. "Nelson" exercised her power. The foghorn was blown and the electric projectors flashed upon the village. The natives thought the two electric lights to be the eyes of some great monster, and when they heard the sound of the siren they immediately concluded that it was the voice of the monster, and, acting under this belief, numbers of them ran away and hid in the bush in terror of their lives.

Enamel Goods.—It would pay some of our English manufacturers to take up seriously the question of enamel shades for electric lighting. At present the best and cheapest goods come from Germany: they are well and truly made, costing something under a shilling, while English plain shades, enamelled iron, of the same nature, cannot be found under at least half as much again, and are then not so well done. There must be an immense trade setting in for these shades for ordinary shop, factory, and kitchen use with incandescent lights.

Oxidising Wires.—A number of experiments in annealing metals have lately been carried out at the Physico-Technical Institution, Berlin. Dr. Löwenherz lectured on these to the Polytechnic Society last week, and in the course of his remarks seems to have suggested that, properly worked out, it may be possible to insulate electric light wires with a coating of oxide. This is certainly a novel and ingenious suggestion. No doubt a means of insulating copper bodily without indiarubber or other compound would prove mightily acceptable, and we are quite sorry to think the idea is an impossible chimera.

Swansea Docks.—The work in connection with the lighting of the Swansea Docks by electricity is proceeding satisfactorily under the management of Mr. Polyblank, and will be completed in the course of a few weeks. The basin and locks and entrance to the South Dock have already been lighted, but the South Dock itself and the west side of the North Dock have yet to be illuminated. The Sunbeam lamps, recently erected, are working satisfactorily at 300 and 500 c.p. A dynamo has been placed in the Harbour Trust electric lighting station, where preparations are actively going on to lay down the whole of the necessary plant, so that electric lighting may be provided at the earliest possible date for the whole of the Swansea Docks.

Good Men in Demand.—It is an indication of the way work is setting to find the demand there is in the electrical trade for men who can use their fingers in a workmanlike way. Experimenters are not required, but a man with his head in his work and a good knowledge of the lathe has often great possibilities opening from time to time. For instance, at a call at the Woodfield Works, we find electrical instrument makers and similar men who knew their work would be welcomed. It is so in nearly all electrical works. Men good at their fingers are wanted, and as at the commencement of railway practice so now with electricity, a man once in, and with his head to see how matters are going, will soon be able to grasp opportunities that must be opening almost every day.

Berly's Directory.—We have received the ninth annual issue of that well-known book amongst electrical men—Berly's Universal Electrical Directory. The volume now contains over 500 pages. The arrangement is very comprehensive, and has its advantage in the fact that pains have been taken to give the electrical names of all countries. Besides the general section of names arranged alphabetically, and in trades, we have an American directory with list of the American institute; also Continental Electrical Directory—French, German, and Italian—and the same for India and the colonies, arranged both alphabetically and in classified trades. It is clearly arranged; the advertisements for the most part are kept to themselves, and the names and classifications are easy of reference.

Medals Offered.—The Société Industrielle d'Amiens offer some awards for 1890, among which are three in the domain of electricity. A gold medal is to be given to the best industrial installation of electric light running at least a year. This installation must be more economical than gas, supposing an industrial establishment of 300 to 350 burners manufacturing its own gas. The second medal is to be given to the best application of electricity to the chemical industry in the neighbourhood of Ameins. The third will be awarded to the author of the best essay on physical science, choice of subject being open. These will remain the property of the society. They must be sent unsigned, addressed to the president of the society, at Ameins, and must contain a sealed envelope with name and address of the author.

London County Council.—At the weekly meeting of the London County Council on Tuesday, the Highways Committee recommended: "(*a*) That the Parliamentary Committee be requested to instruct the solicitor to take the necessary steps for the insertion in the Money Bill of this year of a clause empowering the Council to create stock, and to expend the money so produced for the purposes of the Electric Lighting Acts applicable to the county of London; (*b*) that provision be made in the Money Bill for a borrowing power under the Electric Lighting Act of £5,000 in respect of the year ending December 31, 1890, and of £5,000 in respect of the year 1891, the period over which the repayment shall be extended to be hereafter determined by the Council upon the recommendation of the Finance Committee." The recommendations of the committee were agreed to.

Subways and Overhead Wires Bill.—Thirty-six persons have, within the time limited by the Standing Orders, deposited petitions in the Private Bill Office of the House of Commons praying to be heard in opposition to the passing of the Bill promoted by the London County Council for constructing subways for pipes and wires under the streets of the metropolis, and for the creation of an efficient system of control over overhead wires and cables. The London water companies and a large majority of the electric light companies have consolidated their oppositions, and are represented by only two out of the 36 petitions lodged against the Bill. An analysis of the petitions shows that among the opponents are 13 railway companies, 10 local and other governing authorities, five gas companies, and six telephone, hydraulic and other companies.

Wigan.—Mr. G. Stephen Corlett, A.M.I.E.E., has, on March 1, been taken into partnership by Mr. Maunsell Mercier, mining engineer, of Wigan. The title of the now firm will be Mercier, Corlett, and Co. Mr. Corlett, who was for some years manager for Messrs. Sydney F. Walker and Olliver, of Cardiff and Newcastle, of their North of England district, has been very intimately associated with the application of electricity to colliery purposes, having designed and carried out a number of successful installations of electric light both above and below ground in different parts of the country, in addition to a very varied experience in colliery signalling, ship, factory, and house lighting. The firm have the agency for Crompton's dynamos and motors for Lancashire, North-West Wales, and Westmoreland, and have just taken new and extensive premises at King-street, Wigan. Electrical engineering is becoming greatly in demand in colliery districts, and we have pleasure in noting the establishment of the new firm.

Verity's Concert.—A very enjoyable evening was spent on Friday last, when Mr. J. B. Verity took the chair and presided over the annual smoking concert of Messrs. Verity and Son's Cricket and Football Club. Not content with the usual selection of songs and recitations, the club has blossomed out into a musical authority of some little pretension in classic fields, and boasts a band of its own. On Friday this band gave some selections in fine style, the genial and caustic Mr. George Verity being in great form with his 'cello, and obtained uproarious applause from the roomful. Mr. Lovett King, who was on his way to St. James's Hall, gave some humorous songs in a most amusing style. Comic songs were, of course, in great request, Mr. F. Hill being heartily encored, and as the head of the house sat smiling upon his small army of men, sipping his lemon squash and rapping out for more comic songs, it was most pleasant to feel the wholesome goodfellowship that such a gathering engenders. Some 200 persons must have been present, and the concert was in all ways a thorough success.

Southwark Subway.—The following further particulars are given of the Southwark electric line, and will be interesting to those who have been following the progress of the line. Each engine weighs about 10 tons, the motor is of the Edison-Hopkinson type, and is arranged to take the current from a conductor carried on the wood sleepers between the rails of the line. The permanent engine and dynamo house at Stockwell is nearly completed. In the meantime, and in order to work the line experimentally, a temporary engine and generating plant have been put up at Great Dover-street. The subway is lighted by electricity, glow lamps being employed, the current for which is generated by the same plant as that which supplies the locomotive. It is intended to run trains of three carriages, each capable of carrying 34 passengers, with a three-minute service each way. The trains will be fitted with the Westinghouse automatic brake, worked from the locomotive, which will carry a supply of compressed air sufficient for making 50 stops. When nearly exhausted, the air reservoirs on the engines will be replenished at the main stations.

Brighton Town Council.—An ordinary meeting of the Brighton Town Council was held on March 6th, at the Town Hall, Brighton, the Mayor (Alderman Manwaring) presiding. Some discussion arose out of the proceedings of the Works Committee in consequence of a letter sent by Councillor Blaker calling attention to the damage done to the electric railway by the recent storms, and suggesting that notice be given to remove the railway at once. Some of the members spoke in its favour, and others against, and on a vote being taken an amendment, which was subsequently moved, was lost, and the proceedings confirmed. The proceedings of the Pavilion Committee, which contained the award of Mr. A. M. Channell, Q.C., in the dispute between the Corporation and Maxim-Weston Electric Company, Limited, in respect to the contract for reconstructing the electric lighting works at the pavilion, were moved by Councillor Booth. The proceedings of the Lighting Committee were confirmed, several of the members expressing themselves as being desirous of bowing to the majority, and hoping that now that they were to have electric light it would be made as successful as possible.

Tinting Incandescent Lamp Bulbs.—The following method for tinting incandescent lamps is given by Mr. Arthur S. Huey, of Minneapolis: "Prepare the glass by thoroughly washing in soap and water and drying. Then dip in bath (made by beating up the whites of two eggs in 1½lb. or pints of water, and filtering) and hang up to dry. Dissolve the aniline colour in photographer's common collodion. Red or blue aniline will form clear solutions, while the green solution will require filtering. Yellow aniline forms a handsome colour, but the surface of the glass presents a frosted appearance after the application. Violet and purple colours may be obtained by combining red and blue in different quantities. When the solution is ready, dip the prepared glass bulbs therein, hang up to dry, and finally pass a current through the bulb for half an hour, that the heat thus generated may harden the coating of the collodion, or place in a current of air. The preparation can easily be removed with alcohol or sulphuric ether, but is not affected by water. Experience has shown that the best results are obtained by not using too much aniline. Make the colour light rather than deep, and apply two or three coats."

Folkestone.—At the monthly meeting of the Folkestone Town Council last week the Electric Lighting Committee reported that the Corporation be recommended to give their consent to the granting of the provisional order being applied for by Messrs. Crompton, on the understanding that the area to be supplied be the whole area of the borough, that the contract be incorporated with the order, that a clause be inserted that the existing contract was in no way to be abrogated or nullified, that the power of supplying the whole of the area of the borough be not exercised without consent being given in writing under the corporate seal, that the Corporation be at liberty to take over the provisional order upon six months' notice on the payment of a consideration of £150 to Messrs. Crompton, that the existing contract be modified in regard to the prices for private lighting, and that such consent be communicated to the Board of Trade upon an agreement being entered into by the company and approved by the town clerk. A letter had been received from Messrs. Crompton suggesting that on account of the opposition it might perhaps be desirable to leave the matter for six months. After a discussion upon this point, and as to whether the lamps should be 400ft. apart as now arranged or 300ft., it was determined, however, to hold the company to the contract, which had been already provisionally signed, and the resolution was carried by six to one.

Hydro-Electric-Cable Railway.—In the current number of *Electricité* there is a description of a wonderfully and fearfully arranged combination of sliding electric and cable railway, proposed by M. Berlier. This gentleman, who seems to have been greatly taken with the possibilities of the sliding railway, and at the same time conscious of its wants and emulous to exceed it in practicality, proposes an amelioration, in driving it by electricity instead of jets of water, still keeping the sliding rails, and he prophesies a great renown to French engineers for this invention. The system is a little difficult to realise on account of its complexity, but is illustrated in the original article by cuts. The principle of sliding rails is kept for the carriages, to reduce friction and allow of longer trains or greater speed with the same power of locomotive. For the engine, however, a different set of rails is laid and also an overhead electric cable. The engine obtains purchase, as now, by its weight, and is to be propelled by electric motors of which in the design there are no less than three to each engine, one of these being for the brake. Besides this, there appears to be provision for long troughs of water or feeding canals along the line into which scoops are let down every now and then to replenish the water slides. There is also a cable rolled round a drum, which apparently is to draw the train over the canals where the engine has no rails to run upon. Chemicals are to be added to prevent the water freezing, and generating stations are to be erected at certain distances along the line to be worked by water power wherever possible, all of which, says the ingenious author, "shows the economy of our system."

Baron Battery.—A communication has been submitted by M. Baron to the French Société d'Encouragement upon a new battery of his invention. Lead, carbon and zinc, and in certain cases sal ammoniac and tartaric acid, are combined for the production of an electric current. With these elements the carbon pole does work, as can be seen from the numerous bubbles which form continually all around it, while with other batteries the carbon serves only as conductor. The exciting liquid in this battery is very rich in metallic bodies. It is surprising, if it is precipitated, to see the number of bodies given up, especially if the clearness of the liquid be considered. From the point of view of electric lighting the author guarantees with small elements of the capacity of one pint and a half of exciting liquid, that at least two months of lighting can be obtained at five or six hours a day, having only to change the salt and water in the porous pots once every 10 or 12 days. The preparation of the liquid is simple and not costly, the following being the recipe: Put into pots of stoneware or enamelled iron 20 kilograms of retort or wood carbon; pour in 100 litres of filtered water and 20 litres of sulphuric acid; add 10 kilograms of zinc. The liquid immediately beginning to bubble, sprinkle five kilograms of very pure minium (red lead) or else the same quantity of litharge. Leave to bubble about three hours and then filter. After cooling add 20 litres of nitric acid at 40deg. This mixture will give excellent results: thus, with six small cells of 1½ litres of this liquid, the author has been able to run for 12 days of 24 hours a lamp of eight volts without interruption save for the time for changing the salt and water of the porous cells, which is composed as follows: 100 litres of filtered water with 1,500 grammes of sea salt. The quantity of nitric acid may be decreased and replaced by tartaric acid so as to render the liquid practically without smell. In this case five kilograms of sal ammoniac must be added.

St. Pancras.—The dual committee of the Parliamentary and General Purposes and the Lighting Committees of the St. Pancras Vestry presented a report at the meeting on the 5th inst. upon the action taken by them respecting electric lighting. They gave up the idea of taking premises in Edward-street and in the King's-road, as both were considered unsuitable. It was thought by the committee it would be most desirable to obtain a freehold, and they had found an estate in Stanhope-street of 22 houses for which one of the electric lighting companies had offered £13,000, but had not completed owing to the action of the Vestry in refusing to have private companies to compete. The site contained 20,600 superficial feet and could be had for £10,000, while Edward-street, with only 12,000ft. area, would cost £15,000. Without pulling all the houses down they would have sufficient room with half, so there would be an income from 10 houses of about £300 a year; this in 40 years would pay the principal and interest without costing the ratepayers one halfpenny, and at the end of that period the parish would be the possessor of this estate that had cost them nothing. Mr. Sweet, having moved this, Mr. Purchese contended that they had no right to vote £10,000 away without proper notice. None of the vestrymen knew this was to be brought forward that afternoon, only receiving the notice a short time before leaving home, and not giving them an opportunity of studying the subject, and he protested against such undue haste. Mr. McGregor argued that so important a question should not be delayed another fortnight. As to the ratepayers objecting they were all ratepayers, and were there to do their best. Mr. Westacott said he had valued the property, and if taken to the mart it would fetch quite the amount, and perhaps a little more over that offered to the Vestry. If they were going to have electric lighting, let them have their own freehold for it at a cost of 3½ per cent. He hoped they would carry the committee's recommendation. The report was adopted, with Mr. Purchese as the sole dissentient.

Reading.—At the monthly meeting of the Reading Town Council, the Special Committee on Electric Lighting reported that they had met on the 24th ult. and had an interview with Mr. Kite, the solicitor to the Laing, Wharton, and Down Construction Syndicate, and resolved to recommend the Council to consent to an application to the Board of Trade by the syndicate for a license to supply electricity within the borough for seven years, subject to terms and conditions to be settled by parliamentary agents under the direction of Messrs. Monk and Field, and the town clerk. The Mayor moved the above report. Mr. Martin thought the license should be for a shorter period than seven years. He should much prefer five years. Alderman Hill asked if the granting of the license for seven years would at all interfere with their position if they decided to take up the electric light themselves. A notice of opposition had been given in the other two cases on the ground that the Corporation intended to take up the light themselves. The Mayor said it would not. They could give notice again of their intention to apply for a provisional order. They were not debarred from taking up the question at any time during the seven years; but the probability was that they would not get a license if the syndicate were doing their work well. Alderman Simonds said the Special Committee felt it would be more advantageous to the town to allow the present applicants to work under a license for seven years than to go into the question of taking up electric lighting themselves. If the syndicate kept pace with the progress of electrical science, and Reading did not find itself behind other towns under their management, it seemed to him that it would be much more advantageous to the town to let them continue. If they did not keep pace with other contractors in other towns it would be open to the Council to consider whether it was advantageous to them personally to undertake the management of their own electric lighting, or allow another company to get a provisional order. The report was approved unanimously.

St. Ouen Central Station.—A large central station is being installed at Saint-Ouen-les-Docks, near Paris, by the Société pour la Transmission de la Force par l'Electricité, intended to supply the section of Paris for which this company have obtained the concession, as well as for the suburban towns of Asnières, Saint-Denis, and Saint-Ouen. The current is to be transmitted at the tension of 2,400 volts to secondary stations situated at Paris, Asnières, and Saint-Denis, where it will be transformed and distributed at the pressure of 110 volts. The generating station at Saint-Ouen is to comprise the following plant: Four groups of two Roser boilers, vapourising a total of 16,000 kilogrammes of steam an hour; four groups of twin-cylinder engines, Corliss type, of 300 h.p. each, making 1,200 h.p.; seven dynamos of the Société's own type, giving each 30 amperes at 2,400 volts. The current necessary for excitation of the high-tension dynamos, and also for the lighting of the station itself, various industrial establishments at Saint-Ouen, and the transmission of force for some elevator pumps, will be supplied at the pressure of 110 volts by four Hillairet dynamos of 250 amperes, one dynamo of the Société's own type of 500 amperes, and one Sautter dynamo of 500 amperes. A battery of accumulators composed of sets of 500 kilog. will complete this generating station. The main switchboard will be arranged so that all the high-tension dynamos can be grouped in parallel, and from this will lead the main distributing circuits. There will also be for each dynamo an ampere-meter, a field magnetic resistance, a magnetic and a fusible cut-out, and lastly a voltmeter. A second main switchboard for the low-tension dynamos will serve for the service of the accumulators, the low-tension lighting, and the excitation of the large dynamos. With the 1,200 h.p. the station will be able to supply 12,000 lamps of 10 candles. It is suggested that during the day, when for the most part the plant would be otherwise idle, there is a grand opportunity for the purification of the sewage by electrolysis, the experimental works of the Paris sewerage works being close by the station.

The Electrical Engineering Company of Ireland.—The prospectus has been published of a new company, which should have a good influence in matters electrical on the other side of the St. George's Channel, under the name of the Electrical Engineering Company of Ireland, Limited. The proposed capital is £50,000, with power to increase, this being divided into 24,950 ordinary shares of £2 each, and 100 founders' shares of £1 each, with power for the directors to borrow to the amount of £15,000. The enterprise is a purely Irish one, and will no doubt commend itself to the favour of the investing public in that country. Some of the best-known and most respected citizens of Dublin are on the directorate, Sir Howard Grubb, F.R.S., occupying the position of chairman. The company has been formed to acquire the business and goodwill of the Central Electrical Engineering Company, a private partnership carrying on business at Middle Abbey-street, Dublin, which has established a valuable connection in view of the increasing demand for electric light and power in Ireland, and the time having in their opinion arrived for extending the scope and operations of the business, they have concluded special agency agreements and working arrangements with several of the most important electrical and engineering firms in the United Kingdom, which the directors believe will prove of material benefit to the company. The company have, among others, secured the agency for Ireland of the Brush Electrical Engineering Company, and the advantages resulting from this arrangement are regarded as most important by the directors. In a brief period it is expected that the Corporation of Dublin, who have already obtained from the Board of Trade the necessary license for public electric lighting, will receive similar permission to supply private electric lighting; and from the numerous applications already made to the Central Electrical Engineering Company, it is considered a large business can be done in the city of Dublin alone in fitting up business establishments and private houses along the route to be laid down by the Corporation, while in the installation of isolated plants, in breweries, distilleries, factories, clubs, etc., a very large business would be certain to result. There is also considerable scope for the establishment of central stations and the utilisation of waste water power in parts of Ireland. It is hoped by this means to keep the money to be spent in Irish hands. The company ought to have a good field for work.

A Rival.—Electrical traction engineers will be interested in a rival system of driving tramcars lately tried at Chester. This is a low-pressure compressed air system, introduced by Messrs. Hughes and Lancaster. A number of experiments have been carried out by Prof. Unwin, F.R.S., on the Chester Tramway Company's line, who is stated to have expressed his satisfaction with the system as being practical and less costly than horses. In this system the air is compressed to 170lb. per square inch at a station, and is delivered into mains laid at long intervals alongside the tram line, just below the surface of the roadway. A supply of air is picked up along the route by the car as a fresh charge becomes necessary, and is stored in a receiver. The motor is on the car itself, which, in outward appearance, resembles an ordinary horse car, and the car with its freight moves along without any visible agency whatever. At intervals along the route of the tram line are boxes let into the ground, and having a hinged cover flush with the roadway. Inside each of these boxes is a valve connected with the air main through which compressed air is supplied to the car, and these are termed charging stations. The method of charging is ingenious and simple, and the operation occupies only a few seconds. As the car passes along, a kind of plough is lowered as the car approaches the charging station at a reduced speed. This plough raises the cover of the box, and at the same time, by means of an ingenious valve arrangement, connection is made automatically between the air reservoirs on the car and the charging main. The car is stopped for a few seconds, and upon being restarted the connection with the charging main is automatically broken, and the hinged cover of the box falls down in place. The car is started by admitting the air to the motor, which in the present case is one of Rigg's four-cylinder engines. The attention which is being given to mechanical methods of traction by tramway companies is not confined to electrical systems. We are far from saying that the above-mentioned system is a powerful rival, for as yet no full particulars are furnished, but it is evident that the companies do not intend to capitulate to electricity without a side struggle, and if they think they can do what they wish with compressed air some will do. It lays with the electric companies to find out the advantages or disadvantages of the air system, and push strongly home the advantages they can prove of the electric system. The field will not be won without a struggle.

ELECTROLYSIS OF PLATINUM SALTS.

BY ALEXANDER WATT.

(Concluded from page 187.)

In the opening papers of this series attention was directed to the importance of completely evaporating to dryness the solution of bichloride of platinum obtained by dissolving the metal in the usual way. Having recently had occasion to prepare some protochloride of the metal for experimental purposes, in which it is necessary to continue the evaporation at an augmented temperature—generally estimated at about 400deg. F.—to expel an equivalent of chlorine from the bichloride, I observed that this salt, after being heated to a point very much higher than is required to obtain a perfectly dry product, yielded abundant fumes of chlorine for a considerable time during which the mass, originally of a deep red-brown colour, gradually became exceedingly dark in colour, almost approaching to blackness. A portion of the salt in this state was treated with water, when it instantly dissolved, forming a yellow solution characteristic of the bichloride. It thus became evident that in the preparation of bichloride of platinum the heat may be advantageously raised beyond the point necessary to merely obtain a dry product without impairing, but rather improving, the salt by still more completely freeing it from traces of acid. As the chlorine vapour which thus becomes expelled before the protochloride stage is reached is very considerable, I am disposed to think that at this point the product formed must be an intermediate salt—that is, one which stands between the bichloride and the protochloride, a sesquichloride, in fact. When the heat was still further raised, approaching to dull red heat (and this continued for a long time), the proto salt was gradually obtained, while a very small portion of the mass became reduced to the metallic state. The heat required to convert the bichloride into a proto salt is, in my opinion, much higher than that generally stated in chemical works—namely, about 400deg., or the melting point of tin.

23. *Protochloride of Platinum.*—A quantity of the protochloride having been prepared as stated above, the salt, which is insoluble in water, was digested in boiling hydrochloric acid, in which it readily dissolved, forming a dark red or reddish-brown solution. The concentrated protochloride solution was afterwards diluted with about ten volumes of water, and electrolysed with the current from one small Daniell cell; deposition took place very promptly, but the film, however, was of a dark colour, though perfectly reguline and firmly adherent, the metal having alloyed itself with the brass plate forming the cathode. There was no appearance of the black powdery metal, nor was there any gas evolved at the electrodes.

24. *Protonitrate of Platinum.*—A solution of this salt was prepared by digesting the hydrated protoxide in nitric acid, when a deep brown-coloured liquid was obtained, which was afterwards diluted with water. This solution was then electrolysed with the current from a single Daniell cell, when a very prompt film was obtained upon both sides of a brass plate, the deposit being very bright and white. On scouring the plate after a few minutes' immersion it was found that the deposit adhered very firmly, the metal having well alloyed with the brass surface. Considering that nitrate solutions, as a rule, form very indifferent electrolytes, the solution referred to may be deemed an exception.

25. *Nitrates of Platinum and Ammonium.*—To the foregoing solution was added a moderate quantity of nitrate of ammonium, and the compound solution was then electrolysed with the same current; deposition, however, became somewhat slower than was the case with the simple nitrate. Nevertheless the metal deposited of a good white colour, and in all respects of a favourable character. When two cells were put into series, the film formed somewhat too quickly for an adherent coating, so the anode surface had to be considerably reduced, under which conditions a very good deposit was obtained.

26. *Protiodide of Platinum.*—A solution of this salt was formed by mixing solutions of the protochloride of platinum in hydrochloric acid and iodide of potassium, when a deep red liquid was obtained. This solution was afterwards diluted, and then electrolysed with the current from a single Daniell cell, when a film of platinum soon formed upon a brass plate of a fairly good colour. Gas was freely evolved at the cathode, and iodine set free at the anode, while a deep red salt formed at the latter electrode, which, entering into the solution, soon tinged it a very deep red colour. The film of platinum deposited from this bath firmly adhered to the brass plate.

27. *Biniodide of Platinum.*—To form a bath of this salt, solutions of bichloride of platinum and iodide of potassium were mixed, forming a deep red liquid. The solution thus obtained was electrolysed with the current from a single Daniell, when a film of platinum of fairly good colour was received upon a brass plate.

28. *Protiodide of Platinum in Cyanide of Potassium.*—To a portion of the solution referred to in experiment 26 was added one of cyanide of potassium, when a nearly colourless solution was obtained. This bath proved a very poor conductor, however, requiring the current from three Daniells to decompose it, and the metal deposited very slowly, the film being of an indifferent colour.

29. *Chlorides of Platinum and Potassium.*—A bath of this constitution was made by mixing solutions of the respective salts, the resulting liquid being then electrolysed with the current from three cells, under which conditions a very prompt deposit of platinum of good white colour was received upon a brass plate, the film adhering firmly to its surface. This solution, however, could not be practically applied since the chlorine liberated at the anode would soon render the apartment unbearable in which the operation was conducted.

30. *Chlorides of Platinum and Barium.*—Solutions of the respective salts were mixed, and after allowing the precipitate formed to subside, the yellow supernatant liquor was decanted and electrolysed with the current from a single Daniell, with which a very bright film of platinum was deposited upon a brass cathode, the metal adhering firmly to the plate, with which it had also alloyed, and could only be removed by hard scouring with powdered bathbrick moistened with water—the material I generally prefer to all others for cleaning metallic surfaces to be coated with most other metals.

31. *Persulphate of Platinum.*—A solution of this salt was prepared by treating recently precipitated and still moist sulphide of platinum with nitric acid, with the application of heat. The resulting solution, of a brown colour, was then evaporated to dryness, and the mass obtained was then digested in hot water. When cold, the solution was electrolysed with the current from three cells, when a dark deposit, iridescent in parts, slowly formed on a brass plate, the coating gradually assuming a more metallic appearance, commencing at the corners of the plate.

32. *Platinum Persulphate and Sulphate of Ammonium.*—To the preceding solution was added a moderate quantity of a strong solution of sulphate of ammonia. With the same current as before the deposition somewhat improved, but the metal still presented an iridescent appearance, finally turning blue, a colour which it retained. Large bubbles of hydrogen were evolved at the cathode, some of which rested upon the plate for some time, preventing the metal from depositing at such spots, and when the plate was afterwards examined it was found that the underlying surface on which the bubbles had rested was of a red colour, which contrasted strongly with the bright blue of the rest of the film.

33. *Platinate of Potassa.*—A solution of this salt was prepared by gradually adding to a solution of bichloride of platinum one of caustic potassa, and the mixture was then heated until the precipitate at first formed became dissolved. With the current from three cells deposition, was very slow, but on warming the solution to about 70deg. F. the metal deposited readily, the film being very white, uniform, and thoroughly adherent. A solution of this character might be rendered practically available if kept up to its normal metallic strength by adequate additions of the platinum salt.

34. *Pernitrate of Platinum.*—A solution was prepared by digesting moist sulphide of platinum in nitric acid, with the aid of heat, and then treating the resulting brown liquid

with chloride of barium. After allowing the precipitate of sulphate of barium to subside, the clear nitrate solution was decanted and electrolysed with the current from three cells, when a film of a steel blue colour was obtained.

35. *Pernitrate of Platinum with Nitrate of Ammonium.*—To the above solution was added a moderate proportion of nitrate of ammonia, when the deposits obtained with the same current still assumed the blue colour referred to in the foregoing result. A mixture of the pernitrate with nitrate of potash was also tried, but in this case also the colour of the film was invariably blue.

In pursuing the electrolysis of platinum salts many solutions besides those recorded were tried, but since the results obtained were not of sufficient interest to render their notification of any practical service, they have not been referred to.

BY SIMPLE IMMERSION.

Solution of platinum salt.	On brass.	On copper.	On zinc.	On steel.
Nitrate (weak solution)	Brown stain, then metallic film	Metallic film (*warm solution*)	Metallic film	—
Biniodide	Same	Black metallic film (*warm*)	Prompt metallic film	Dark stain (warm solution)
Bromide	Bright metallic film	Black stain (warm solution)	Iridescent metallic film	—
Potassio-bichloride ...	—	Black stain (warm solution)	—	—
Bichloride (weak solution)	Bright metallic film	Black metallic film	Black metallic film	Dark stain
Bichloride in sulphocyanide of potassium	Slight stain warm solution	Metallic film (warm)	Dark stain	Slight stain
Protochloride in hydrochloric acid (warm solution)	Bright metallic film	Bright metallic film	Metallic film	Metallic film
Nitrates of platinum and ammonium	Slight stain	Bright metallic film	Stain	Dark stain
Bichloride neutralised with chalk	Slight stain	Light brown stain	Black metallic film	Metallic stain
Bromide in pyrophosphate of soda	Iridescent film	Iridescent film	Black stain	—
Chlorides of platinum and ammonium	Bright metallic film (*warm solution*)	Bright metallic fim (*warm*)	—	—
Bichloride in hyposulphite of soda	Blue iridescent film	Iridescent film	Brown stain, iridescent in parts	Bright yellow stain
Chlorides of platinum and sodium (*warm solution*)	Bright metallic film	Bright metallic film	—	—
Bichloride neutralised with magnesia	Slight stain	Slight stain	Black stain	—
Nitrates of platinum and potassium (*warm solution*)	Brown stain	Iridescent metallic film	—	Dark stain
Nitrates of platinum and ammonium (*warm solution*)	Brown metallic stain	Brown metallic stain	Iridescent film	Brown stain
Protiodide (*warm solution*)	Fine black stain	Metallic film	Metallic film	Dark stain
Chlorides of platinum and barium (*warm*)	Dark metallic film	Bright metallic film	Metallic film	Metallic film

Deposition of Platinum by Simple Immersion.—It was next determined to ascertain what action the solutions of the various platinum salts would have upon brass, copper, etc., by simple immersion in the respective liquids, with a view to determining whether some of them might be utilised for producing metallic or coloured stains upon such metals for ornamental purposes in the arts. It will be seen by reference to the above table that certain platinum solutions appear specially applicable to the purposes indicated. Since some of the solutions named yield bright metallic films of platinum, upon brass and copper more especially, it will be readily seen that in cases where such a film would be desirable these solutions would be likely to prove serviceable. Again, in some cases rich brown tones of various shades can be obtained upon the various metals indicated, and since these colourations may be varied, *ad infinitum*, according to the strength or weakness of the solution used, it is not unlikely that the practical operator may derive some advantage by trying for himself small quantities of either liquid that he thinks likely to be of most service to him. It is perhaps unnecessary to state that the various platinum solutions might be applied to portions of an article by means of a soft brush until the desired effect is produced. In the colouration of metallic buttons and small fancy goods much may be done by the ordinary process of dipping in some of the platinum solutions mentioned. It will be noticed, however, that in some of the simple immersion experiments the solution was used warm. This was suggested by the fact that some of the liquids when cold produced only a slight stain upon the metal tried, and it was thought that better and more marked results would be obtained by warming the liquid, and the subsequent trials proved that such was in fact the case, and that far better staining action was produced when the solutions referred to were moderately heated, a temperature of, say, from 90deg. to 120deg. F. being probably sufficient in most cases.

It should be noted, in conclusion, that in those instances in which a "bright" metallic film was obtained by simple immersion the metal was of a pure platinum white, and the coating was perfectly adherent, leading to the inference that such solutions might be found useful for imparting a film of platinum to small brass or copper fancy articles by the usual dipping process.

A REVIEW OF MODERN ELECTRICAL THEORIES.*

BY PROF. WM. A. ANTHONY.

(*Concluded from page 199*).

Continuing our hypothesis, an E.M.F. would be anything that tends to set the wheels in motion. The wheels are set in motion if a limited number acted upon by the E.M.F. are separated by a conductor from the other wheels of space; but even if they are not separated—that is, if the conductor does not form a closed circuit—the wheels are rotated through a small angle depending on the elasticity of the wheelwork. This displacement constitutes an electric charge, the tendency of the wheelwork to spring back is difference of potential, and this difference of potential is maintained by the E.M.F. Here allow me to call attention to the distinction between difference of potential and E.M.F. I often see statements that indicate that the distinction is not clearly kept in view. In that excellent little volume, "The Dictionary of Electrical Terms," the statement occurs that E.M.F. is *due to* difference of potential. It should rather be difference of potential is due to E.M.F. Difference of potential is *an* E.M.F., but not all E.M.F.'s are difference of potential; and, furthermore, I can think of no case of difference of potential that does not owe its existence to some other E.M.F., not difference of potential. Difference of potential is a moving force acting from within; E.M.F. acts from without. Difference of potential results from a changed electrical distribution, an electric strain, and represents the tendency to return to the state of equilibrium; E.M.F. is the something from without that produced the electric strain. Consider our wheelwork illustration. I may seize a wheel here and turn it, but I can only turn it through a small angle before the elastic forces, brought into play by the distortion, balance the force that I am able to exert. My force is E.M.F.; the elastic forces are difference of potential. Let Fig. 2 represent a voltaic cell with its copper and zinc plates and dilute acid; we know that something takes place by which the copper becomes positive and the zinc negative, and, if the copper and zinc be joined by a wire, electricity is said to flow from the copper to the zinc through the wire, and from zinc to copper through the liquid. The flow through the liquid used to be explained by assuming the zinc to be positive and the copper negative within the liquid; just the reverse of what we find without. But connect the copper to the zinc by a wire under the liquid, the current flows through the wire from the copper to the zinc. The copper, therefore, is not negative, but everywhere positive. Then,

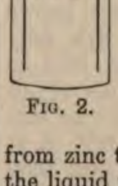

FIG. 2.

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*Paper read before the American Institute of Electrical Engineers New York, Jan. 21, 1890.

why does the current set from the zinc to the copper through the liquid? Because there is an E.M.F., not difference of potential, mind you, for the difference of potential tends to cause a flow the other way, but a something that forces the current through the liquid against the electric pressure. The cell is an electric pump that pumps electricity from the zinc into the copper until the pressure becomes so great that the pump stops. Open a passage from the copper to the zinc by connecting the two by means of a metallic wire, the electricity flows and relieves the pressure, the pump begins to work, and so maintains a continuous flow. No; E.M.F. is not difference of potential, although difference of potential is E.M.F. It is even possible to produce an electric current without any difference of potential whatever in any part of the circuit, just as it is possible to produce a flow of fluid without any difference of pressure.

Whatever difference of potential may be, it behaves like a force developed by an elastic displacement in a solid body. Whatever magnetic forces may be, they behave as though produced by the motions of inert masses. An E.M.F., suddenly brought to bear at a given point, has to overcome not only the elastic force, but the magnetic inertia. In other words, an E.M.F., tending to produce current, immediately develops a difference of potential against which it must act, and also develops magnetic forces which retard its action; so a fluid-moving force meets opposition in the elastic force of the fluid and in the inertia of its particles. But the effect of any such force is propagated through the medium with a definite velocity expressed by the well-known formula—

$$\mathrm{V} = \sqrt{\frac{\mathrm{E}}{\mathrm{D}}}.$$

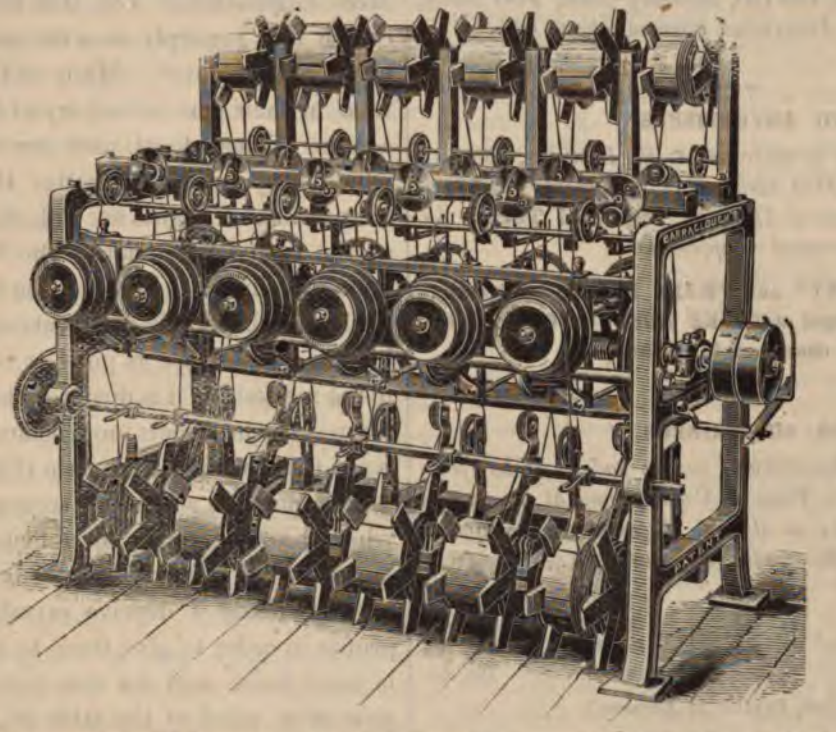
Electric displacements ought, therefore, to be propagated with a finite velocity which should have some relation to the ratio between the electrostatic effects, analogous to elastic displacements, and the electromagnetic effects analogous to the effects of moving masses. You all know that it is shown that this velocity is expressed by the ratio of the magnitudes of the electromagnetic and electrostatic units quantity, and you know also that determinations of this ratio show it to be the velocity of light. This determination gave a very strong support to Maxwell's electromagnetic theory of light, and coupled with the fact that observations, so far as they went, indicated that magnetic effects are propagated from the sun to the earth with the same velocity as light, made the theory at least extremely plausible. But within two years the wonderful experiments of Hertz have demonstrated beyond question that electromagnetic waves travel through space from every source of alternating currents or potentials, and that the waves travel with the velocity of light. In this city there are, I suppose, many alternating-current systems. When we think of these in action we are apt to think only of the activity in the conductors of the machines, the lines, the transformers, the lamps, and yet we know that in all the space around there is activity. Waves are chasing each other through this room, through our streets, our houses, our offices. They are everywhere present. We are bathed in this agitating medium every moment, and yet we live, and not only live, but are totally unconscious of the activity that surrounds us. No sense responds to the wave motion that fills this space. And yet, when these waves become short enough and frequent enough, they do affect our sense of vision, and a vast array of phenomena that otherwise would have had no existence for us are made known to us through this special sense. But the eye only responds to waves of $\frac{1}{70000}$ to $\frac{1}{37000}$ of an inch in length, while the length of the waves emitted by one of our alternating-current systems is 600 miles. The waves that affect the eye must occur at the inconceivable rate of at least 400 millions of millions per second, while less than 300 waves per second are emitted from our alternating systems. These waves come very far short of the number necessary to affect any of our senses, but we have been able to demonstrate their existence, at least we have been able to show that something possessing all the characteristics of wave motion exists in the space around a source of alternating currents or potentials. It is something to know that waves of such enormously different lengths and frequencies exist in the medium that is agitated by waves of light. It is something to understand that our sources of alternating currents are centres of radiant energy, differing from light only in wave length; and since we have begun to appreciate this fact, we have often asked ourselves the question, Can the rate of alternation be increased until the whole apparatus should glow with light? Although the enormous rapidity required seems to render this direct solution impossible, it seems to me there must be a way to obtain the light we want without all this waste of energy. I cannot believe it will always be necessary to develop waves of all lengths, from many miles down to a hundred thousandth of an inch, in order to obtain the narrow range of wave lengths by which we see. I do not know of any practical way of obtaining the few wave lengths that constitute light without at the same time producing the others, but it is done. The glow-worms do it, the fireflies do it, the lantern-beetles do it, and I believe the time is coming when man can do it. Instead of getting 10 16-c.p. lamps per horse-power we ought to get 200. I don't know how it is to be done. I don't expect we are going to make alternating machines to produce 500 millions of millions of alternations per second. But possibly we may solve the problem indirectly by the use of some substance having a special rate of vibration, such as the gases. Possibly we may be able to excite electrically the fluorescent salts. Possibly we may be able to charge and discharge a condenser and take advantage of the oscillatory discharge to set up vibrations of the frequency required. Possibly we may discover the secret of the glow-worm and firefly and substitute electric for the insect energy. I know it will take several fireflies to equal a 16-candle lamp, but it will also take a good many fireflies to develop a horse-power. But although I do not see at present any practical solution of the problem, I repeat, I believe the problem can and will be solved. We are not going on for ever burning a coal-mine whenever we want a little light, neither are we going on for ever converting the energy of coal into heat when it is mechanical or electrical energy we want. From the very nature of things, not more than one-fourth or one-third the heat so produced can be transformed into any other form of energy. The energy of fuel *can* be converted into mechanical energy without first becoming heat. It is so converted in every animal movement. The way exists; let us find it. Find this, and the way to make light only, when it is only light we want, and we shall have lengthened the life of our coal deposits five or ten times. The man who solves either one of these problems will be the greatest discoverer of this or any other age. If he gets a broad patent on it, he will have 17 years of the grandest litigation the world ever saw.

Now I can imagine that some electrician will consider that the first part of this paper dealt with matters that are of no practical consequence in the use of electric currents. Of what practical consequence is it whether force is conveyed to a distance by means of a medium or simply acts at a distance. What does it matter whether electric energy is conveyed by the conductor or through the dielectric? We know how to proportion and dispose our conductors to produce a given effect, and that is enough. But consider what we have learned already of the intimate connection between light and electricity, and I think you will agree that the more we know of the ultimate nature of electricity the nearer we shall be to the solution of the great problem to which I have referred, and the solution of either one of those problems would revolutionise some of the most important industries of the world. May not the solution of at least one of these problems be accomplished, and the results exhibited at the great exhibition to be held in New York in 1892? What a wonderful achievement it would be to light all those great buildings without heat, or drive all that vast array of machinery without a fire!

WIRE-COVERING MACHINE.

Among the recent improvements made in machinery for insulating and covering electric wires and strands, Barraclough's patent wire-covering machine, which we illustrate herewith, shows a considerable advance in the process of covering wires with cotton and other fibrous yarns. The great desideratum in this branch of manufacture is to obtain a perfectly even covering—the wires must show no inequalities, no thin or thick places, and in order to effect this the yarns used must be of good quality and even spinning, and the application of the yarns to the wires must be faultless. Considerable difficulty is experienced in arriving at a perfectly even covering, by reason of the breakages of the yarns, the carelessness and want of skill of the operative, and also by defective machinery. The covering heads also revolve at a very high speed, the yarns are therefore liable to break and the bobbins frequently become empty, causing inequalities in the covering, more especially when the attendant fails to observe the breakage or failure of the yarn. The machine has therefore to be frequently stopped, the broken yarn or yarns pieced up and fresh bobbins inserted in the flyers. During this operation the whole machine is standing still, necessarily involving great loss of production.

The object that the new machine is constructed to fulfil is twofold: (1) The construction of wire-covering machines in such a manner that each covering head can be worked and stopped quite independently of the others; thus, if from any cause one head is stopped, the others are not affected, but continue their work at full speed. (2) The application of an automatic stopping apparatus to each flyer, so that as soon as a thread breaks or a bobin becomes empty the head stops automatically and instantaneously, thus preventing imperfect work and enabling the operative to see at a glance which head needs attention.



These machines are usually made with six heads to cover six wires simultaneously, and each head has two flyers, with automatical stop motion, arranged to run in opposite directions so as to apply two coverings to the wire, right and left hand. These heads are quite independent of each other, and can be stopped and started at will.

The following description of one head of the machine will render the mechanism clear to our readers. On the driving shaft, which extends along the machine, a number of discs are keyed, there being one to each head. Adjoining each disc, and to a certain extent covering it, is a grooved pulley. One side of this disc is hollowed and has a circular leather plate fixed in it, which acts as a frictional surface by which the grooved pulley is driven when pressed up to the disc. Over the pulley an endless band is passed, which drives the two rotating covering flyers in opposite directions. The grooved pulley can be slid upon the shaft by means of a lever, by moving which to the left contact of the frictional surfaces is established or *vice versa*. The wire is drawn from the reels—shown in place at the upper part of the machine—and is passed through the hollow spindles of the covering head, after which it follows the course shown until it reaches the draw roller on which it is taken several turns. The rate of rotation of the draw roller regulates the speed of covering, and the reels, upon which the covered wire is wrapped, are driven by a band from the shaft on which the draw roller is fixed, so that the speeds of the two are relatively proportionate. The covering material is carried in spools fixed upon pins fastened in the face of the covering flyers. Instead of driving the draw roller shaft by bevel gearing, it is driven by a worm and worm wheel, the former being fixed on the driving shaft. In this way a regular speed of draw through is obtained entirely free from the irregularities arising from back lash when ordinary gear wheels are used. This is of the utmost importance to ensure perfectly even covering. The stop motion consists of a small finger attached to the covering flyer in such a way that as the latter is rotated the finger tends to assume a perpendicular position. It carries an eye through which the yarn is passed, the tension upon the latter being sufficient to prevent the finger from taking the position named. As soon as the yarn breaks the finger assumes the perpendicular, and in its rotation strikes one end of a small lever which is oscillated through an arc of 90deg. The movement communicated to the small lever causes a small mechanism to descend and press a weight, which is suspended by a cord in the slot of a large lever. On the latter is a projection, in front of which the weight is forced, and is thus brought into the path of a cam on the driving shaft. In this way the lever is pressed back, and by means of a connecting rod it raises and releases a small lever, so that it can be drawn over by a spring, and the section is thus stopped in the manner previously described. To restart the machine it is necessary to piece up the thread and restore the levers to their original position. This is done by a small lifting rod specially provided and arranged to act for both discs.

The machine has met with considerable success, supplying as it does a piece of apparatus which is much required, the manufacturer is rendered in a large measure independent of highly skilled labour, whilst the production is relatively much higher than that of other machines from the reason that when one head is stopped the other heads are wholly unaffected thereby. Therefore perfect covering, increase of production, and diminution of cost are attained by the use of this machine. An additional advantage connected with this machine consists in the wide range of thickness of wire which can be covered. The machine is made by Messrs. Thos. Barraclough and Co., Limited, Globe Works, Manchester.

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Specimen copies of the paper will be sent on request.

THE TRADE AND THE GENERAL PUBLIC.

There is a smouldering dissatisfaction that bodes ill to some of the owners and manufacturers of patent articles unless a change for the better takes place very soon. It will be preferable to deal with the general question at the present moment rather than to particularise, though to do the latter might give a piquancy and a point to our remarks which the more general method of treatment will not.

The broad question to be considered is, whether it is wise to put the middleman and the public upon the same level, to supply the purchaser to the extent of hundreds or scores of pounds at the same prices and under the same conditions as the purchaser to the extent of shillings is supplied.

Assume, if you like, that middlemen are a nuisance, still they are, in most cases, a necessity. Are they a necessity in the electrical industry? Most emphatically Yes, and, further, they will increase and multiply to a far greater extent than is usually anticipated. Many of the large companies, wise in their generation, try to appoint local men as agents. These local men can work the district in which they reside far better than can the manufacturer. Such agents are not offered the same terms as the casual customer. The former, so to speak, makes business; he, in fact, endeavours to make all likely purchasers in his district believe the goods he has to sell are as good or better than any other in the market. If it is disputed that he makes business, we may say he directs more business towards a certain point than would be the case if it was left to chance.

The question assumes a somewhat different aspect when the owner or the manufacturer has a monopoly. He may thus argue: Everybody must come to me, so why should I deprive myself of any part of my profits in order to give them to a middleman. There is much to be said for this view of the case, but it puts us in mind of the fable of the goose that laid the golden eggs. The owner, as all know, was in a hurry to get rich and killed the goose, so the manufacturer or owner of a monopoly may be anxious to get all he can while the monopoly lasts, and after that—the deluge. In other words, the goose is killed. At the end of the term during which the monopoly lasts, a hundred competitors spring up. The public care nothing and think nothing about the late monopolists, their needs are served by makers and agents at their own doors. They buy of the person that gives them the least trouble, provided prices and quality are the same. If, on the contrary, the late monopolists had agents everywhere competitors would find it difficult to get much business—in fact, it would be almost impossible to make a new business pay. The newcomer could offer no greater facilities than the old, and buyers would have no reason to go elsewhere when they would get no greater facilities, no better prices, and no better quality. We may be at liberty to doubt whether the policy of making all men come to Rome is the right one. Do those who pursue the policy ever think of the future? Is their business concern of to-day only, or do they hope to raise up such a business that it may last through many years, if not through many generations? Whatever their views, we might venture to indicate a course of reading.

There is an old play, entitled "The Honourable History of Friar Bacon and Friar Bungay." Friar Bacon is a clever old soul, and wants to protect his native land, so by his skill he frames "a monstrous head of brass," which is to speak, and the result to be to "girt fair England with a wall of brass." The friars watch to weariness to hear the head speak, but fall asleep to recruit exhausted nature, leaving Miles watching, to awaken them if the "brazen head" speaks. Of course it speaks, but so inconsequently that Miles does not awaken his master. It speaks three times, saying respectively "Time is," "Time was," "Time is past." At the last speech a hand appears and breaks the head to pieces, then Miles awakens his master, but too late. Bacon has to admit—

> "'Tis past indeed, . . .
> My life, my fame, my glory are all past."

In reference to the case before us, we might say "Time is," though for the due organisation of lasting business "Time will soon be past." There is time now to consider which policy is the more profitable in the long run, though there will be no opportunity of doing so after another couple or so of years.

General dealers in things electrical complain that in certain directions no incentive is given them to sell certain goods. The public obtain the same terms as the dealers, hence the latter are gradually dropping what might have been a fairly remunerative part of their general business. Will they take up this branch again when patents run out and competition begins? and will they return to the old love or go on with the new? Probably go to the new, and then how will it affect the old factories? The case becomes more grave when it is a company and not a firm or an individual which owns the monopoly, for the shareholders are then the sufferers. They may receive good dividends for a few years, under one policy larger than would otherwise be the case, while under the other policy they might have lower dividends, extending, however, over a much longer period. It will thus be seen that the question is to a certain extent solvable, and we expect most readers would agree with a policy that took into consideration the middleman, that arranged to have a network of agents, and to offer every possible facility to purchasers. Then when the evil day came, and the patents ran out, competition would be rendered much more difficult. The trade could be kept in the hands of those who had developed it, and a long reign of prosperity would be the condition of the shareholders.

CORRESPONDENCE.

SIGNALLING BY INCANDESCENT LAMPS.

To the Editor of the Electrical Engineer.

Sir,—I read to-day in your journal of the 28th February an extract from *Electricité*, which gives an account of some experiments in signalling by means of incandescent lamps placed at the mastheads of an American cruiser, the "Chicago," at Toulon, under Admiral Walker.

Last August, while dining at the "Falcon," at Gravesend, with some friends one evening, I witnessed a trial taking place with these kind of lamps for signalling on board a Chilian ironclad, the "Blanco Encalada," I believe.

The dots and dashes of the Morse code were shown most distinctly, as also a method of using coloured lamps with the white for representing the letters of the alphabet.

The lamps were strung from the mainmast head to a point some distance above the deck, and were on three circuits—I should say, six lamps being in each. The white lights were used in the same way as a Morse signal light, short flash for the dot, long one for the dash. Then white and green, or white and red; and for terminating a message (I suppose) all lights flashed together, and then were cut off.

The effect was most interesting and pretty, but was scarcely noticed by the people present.—Yours, etc.,

H. Benest.

London, 7th March, 1890.

THE LATE W. H. SNELL.

It is with great regret that the writer records in these columns the passing away of one who was for some years an intimate associate with him in his work, as well as a friend of still longer standing. The writer, perhaps more than anyone, may claim to have guided the career of the late Mr. Snell, first in his student days and subsequently in his literary work. The late Mr. Snell was a Devonshire man, his family residing at Tiverton. The rudiments of his electrical training were obtained at the school in Hanover-square, while his more practical work was as engineer to one of the Atlantic liner companies at Liverpool. It was at the writer's request, after Mr. Snell left Liverpool, that he should try his hand at literary work. The result was a success. Mr. Snell devoted himself more and more to this work, till upon the resignation of the late editor he was requested to undertake the responsibilities connected with the editorship of the *Electrician*, of which paper he had for some time acted as sub-editor. There is no doubt but that in the conscientious discharge of the duties that fell upon him he laboured so persistently as to undermine his health. Compelled at length, he too late attempted to rest, but the fatal germs had been sown, and in a few short months he passed away. A promising career has been cut short by the demon of responsibility and overwork. There is no doubt the weight of the responsibility was felt to be greater because of the peculiar circumstances which led to his position, and his life has been the sacrifice. But of the man. He was a genial companion, a thorough student, conscientious to the heart's core—though somewhat reserved—and preferring quietness to opposition, though quite able to hold his own in argument when he felt it necessary.

FOWLER'S HAMMERING AND WELDING MACHINE.

In the electric welding machine of Prof. Elihu Thomson the great difference between the electric process and the ordinary process is that although the metals are pressed together, they are not worked at the moment of welding, but are left for the hammering down to be done afterwards. This, to practical men, has appeared a certain difficulty in adapting it to ordinary use for welding, for to make a successful weld the metal should be wrought with the hammer, or an equivalent, as well as pressed together. Of course any improvement in successful electric welding machines must be based upon Prof. Thomson's discovery, but an engineer who has worked out a practical improvement in electric welders maintains that a true weld is not obtained unless the "working" of the metal is performed before the current of electricity is withdrawn, otherwise it is too often merely a sticking together of the metals while hot.

The machine herewith illustrated is patented by Mr. Herbert Elsworth, of 119, Davenport-avenue, New Haven, Connecticut, U.S. It is a machine for welding pipes, rods, bars, or other pieces of metal by means of electricity; and the object of the invention is to provide a machine which shall form the weld by working the joint without removing any of the metal, therefore approximating more nearly, by the use of this machine, to the method of hand or power hammer welding.

For this purpose he employs, by preference, means for holding the parts stationary, and for supplying an electrical current to the respective sections which are to be united; means for forcing or crowding the sections endwise, whereby, when the metal is fused, the abutting ends are upset; and means for rotating welding appliances, which may be either hammers or rolls, about the work, and delivering the blows or pressure upon the upset part of the pipe, whereby it is hammered or rolled down at that point and a secure weld formed without removing any of the metal from the joint.

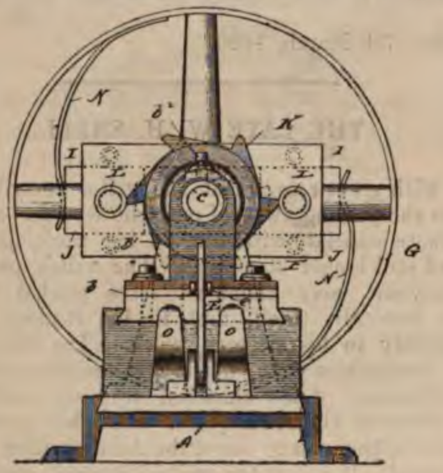


FIG. 1.

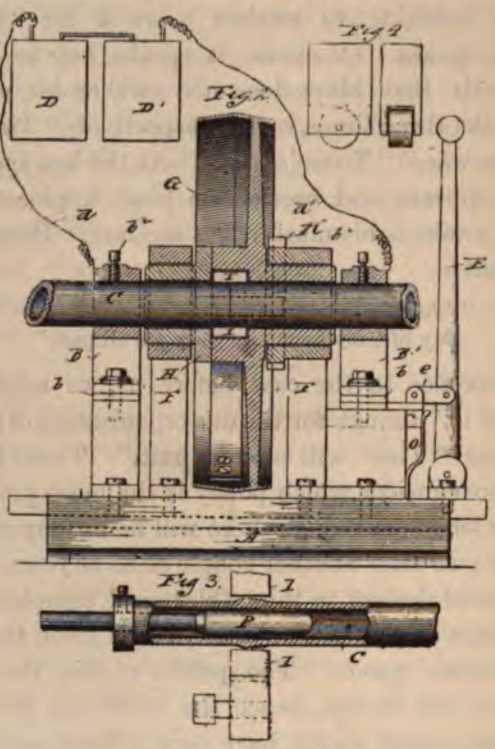
In the accompanying drawings Fig. 1 is an end elevation of the machine of the preferred construction, some of the parts broken away and others omitted.

Fig. 2 is a side elevation partly in section.

Fig. 3 shows a section of pipe with its end upset and a mandrel inserted in the pipe, and showing the hammer ready to act to form the weld; and

Fig. 4 shows a form of roll which may be employed instead of the hammer described, the views being respectively a side and an edge elevation of the same part.

The machine is mounted on a suitable base, A, having the standards, B, B^1, with bearings therein for the pipe, C. These standards are insulated at b from the base of the machine, and are connected respectively to the batteries, D, D^1, by the wires, d, d^1. Standard B is movably mounted in ways, and is adapted to be moved by means of the pivoted lever, E, having the link, e, connected to a stud on the said standard. The sections of pipe may be secured against rotation in the standards, B B^1, by means of the set screws, b^2. F F represent uprights or standards also secured to the frame, A, and which have in their upper ends journal boxes or bearings for the hub of the pulley wheel, G, which will be rotated in its bearings by means of a suitable belt. H represents a guide flange secured with the hub of pulley, G, and having ways formed therein within which ways hammers, l, move. These hammers are preferably mounted upon head blocks, J, and they have curved faces as shown by the dotted lines in Fig. 1. Instead of the hammers, the rolls shown in Fig. 4 may be secured in the ways and adapted to form the weld by being rotated in contact with the upset portion of the pipe. It is preferred, however, to form the weld by means of the hammers shown in Fig. 1, which are reciprocated by the cam wheel, K, which is secured to or formed integrally with the fixed bearings of the pulley-hub, and which cam wheel is adapted to engage studs, L, projecting from the sides of the hammer-heads. Such heads are backed by suitable springs, such as those marked N in the drawings which have a constant bearing at their free ends upon said heads, and have their opposite ends secured to the rim of the pulley. A spiral bow or other form of spring may be substituted, or other means may be employed for reciprocating the hammer to deliver the blow. Leaf springs, O, are preferably used, which are secured at one end to a fixed part of the frame and which have a bearing at their free ends upon the sliding standard B^1, so that after the ends of the pipe have been upset and the welding commenced, the standard B^1 may move back with the pipe as the latter is slightly extended by the welding operation.



FIGS. 2, 3, AND 4.

The operation of the machine is as follows: Two sections of pipe, rod, or bar are secured in the bearings of the standard, B B^1, with their ends in contact, and the current of electricity is passed along the wires to the pipe. When the abutting ends of the sections are sufficiently heated or fused, the movable standard B^1, with its section of pipe, is forced against the other, thus upsetting the ends of the pipe, as shown in Fig. 3. The pulley carrying the hammers or rolls is then rotated around the work and the blows or pressure delivered upon this upset portion of the hammer or rolls, as the case may be, thus spreading the metal on both sides of the joint and forming a secure weld without removing any of the metal raised by the upsetting. Where the machine is used to weld pipe, a mandrel, P, may be inserted to prevent unevenness on the interior.

The invention consists, broadly, in the combination of suitable mechanisms for holding two sections of metal pipe, bar or rod, with their ends in contact, fusing said ends by means of an electrical current, upsetting said ends and suitable rolls or hammers for reducing or welding this upset portion without removing any of the metal from the pipe.

A Large Contract.—A contract involving £400,000 has just been signed for the electrical equipment of the street railways of St. Paul and Minneapolis.

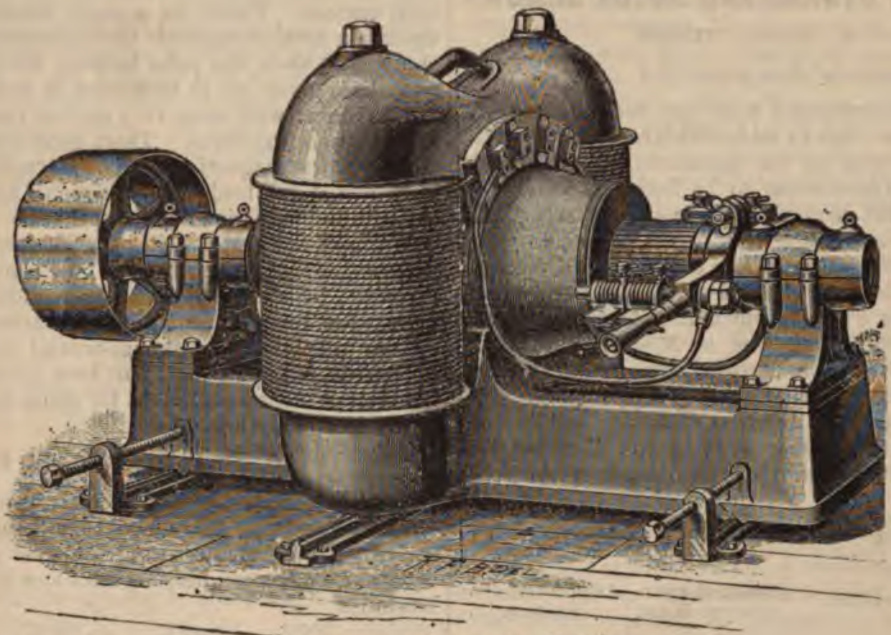
LARGE ELECTRIC MOTORS.

The continued development of the use of electric motors is leading to the building of larger and larger types of machines. We illustrate herewith, reproduced from the New York *Electrical Review*, a 75 h.p. electric motor of neat and mechanical design, now made by the Sprague Electric Railway and Motor Company.

The motors are automatic in their operation, regulating for a constant speed with varying loads, a necessity in driving most kinds of machinery. The regulation is entirely in the winding of the motor, and consequently there are no mechanical governing parts to get out of order. Self-oiling bearings are used by means of which a thorough and complete lubrication of the armature shaft in its bearings is maintained.

ELECTRIC LIGHTING SCHEMES AT BRIGHTON.

Mr. Killingworth Hedges has replied in the *Sussex Daily News* to some criticisms of Mr. Alderman Hallett upon the Brighton electric lighting scheme. It appears, says Mr. Hedges, that Ald. Hallett has entirely confirmed the resolution which was passed at the meeting where I had the honour of being asked to give my views as an independent consulting electrical engineer. Ald. Hallett advocated what he terms a "composite gas engine scheme," which he stated had been successfully applied to the lighting of two Banks and the works of the makers of the gas engines. The object of the meeting was in measure to show that this scheme was experimental, and it requires no comment from me, as he himself states that "the system had not been utilised for public supply." Apart from this fact, Mr. Crompton's report appears to entirely confirm the opinion expressed by me at the meeting. The following enables a comparison to be made as to the various statements :



75 HORSE-POWER ELECTRIC MOTOR.

ESTIMATED COST OF WORKING ELECTRIC LIGHT PLANT.

		Mr. CROMPTON.	Ald. HALLETT.	Mr. K. HEDGES.
Units sold		100,000	168,000	
Lamps attached		3,750	2,000	
Motive Power.	Gas Engines. Cost per unit without interest	7·9d.		
	Cost per unit with interest say 2·85d.	10·75d.		Greatly exceeding 6d. per unit.
	Steam Engines. ditto.	8·2d.	2·3d.	
Repairs and renewals of storage batteries		14·5 per cent.	12 per cent.	Could not be kept in repair for 12 per cent.

ON SUPPLY FROM STORAGE BATTERIES.

Mr. Crompton says : Batteries were designated as regulators and were not intended to maintain the supply for any length of time.

Ald. Hallett says : The storage cells when charged fully will contain enough to supply their share for three days.

Mr. Ince says : In the discharge they lost 40 per cent., so that they had to manufacture 40 per cent. more current than reached their customers.

I have not brought down the units sold and lamps attached to the same amount, but if this is done Ald. Hallett's figures will be found to be still more erroneously under-estimated. It has been suggested that I had never heard of a gas engine being started by a secondary battery. I have done so, but no employé of mine would venture the experiment in my presence. May I remind your correspondent that although dynamos may be used as motors, there is a wide difference in the construction of the two, which he would speedily find out if he tried to use the former to start a 21 h.p. gas engine.

I have no reason to alter my opinion as to the relative commercial merits of the high-pressure transformer system compared with the low-pressure battery reserve plan. In my journey through France I have found the transformer system progressing far more rapidly than the other, which is not even used in Paris, where several methods of public lighting are being competitively tried. [The list is then given, which we gave last week, of the Italian central stations which have been already constructed to work with alternate-current transformers]. The transformer system, Mr. Hedges continues, is a great success ; no better instance can be given than the installation for lighting the small town of St. Troper, South of France, which is about 30 miles from the nearest railway station. I attended the inauguration of the electric light last year, and paid a second visit a few days ago. Everything was working quite smoothly. One man and a boy managed the station, which lights the whole of the public streets and many of the shops. The inhabitants are much pleased with the startling innovation of electric light instead of the old oil lamps which had hitherto been employed.

THE QUESTION OF PRICE.

Ald. Hallett mentions my book. I presume he alludes to that entitled "Central Station Electric Lighting," (Spon). A glance at the appendix will show that I have tabulated a large number of central stations both at home and abroad, and also that there is not one of these supplying electric light at as low a charge as is proposed for Brighton, namely, 6d. per unit. Some of the foreign stations pay dividends, but up to the present time I hear of no reduction in the cost of the supply, and therefore I cannot see why the ratepayers of Brighton should be that there will be no loss if that current is sold at 6d. per unit. I quite agree with Mr. Crompton that the total cost will be less if 200,000 units are sold. This is a large amount to get people to take without running special mains outside the general district. If the street lamps were to be lighted by electricity there would be a fixed amount to go on, which might be made to pay cost of working the plant. As it is, everything is cut too fine, and the item of contingencies does not appear. Therefore an accident which might destroy some portion of the plant would have to be met by drawing on the capital account. How can a renewal fund be created out of the small percentage allowed, which will certainly be absorbed by necessary repairs? In conclusion, I must apologise to Mr. Shoolbred if I have criticised his scheme too severely. I am sure he will make it a success if it is possible to do so, and I am now informed that he did not advocate the use of gas engines and supply from batteries, which scheme was entirely the creation of Ald. Hallett, who appears to have obtained his information almost entirely from an advertising treatise which was published some time ago by the Electrical Power Storage Company, who, as patentees of the system, cannot, therefore, be looked upon as independent authorities.

SOME POINTS IN DYNAMO AND MOTOR DESIGN.*

BY W. B. ESSON, MEMBER.

(Continued from page 198.)

Regarding drum armatures I have not been able to get such full information; but in table III. are given the diameters and ampere-turns on the armatures of some well-known machines. There seems to be little agreement, at first sight, between the diameter and the ampere-turns; but if these are plotted as abscissæ and ordinates respectively, it will be found that a straight line can be drawn through the intersection of the axes giving a very fair mean of all the points excepting 5 and 7, which are abnormally high. The relation denoted by this line is $A_2 =$ diam. in centimetres × 570. It will be understood, of course, that the induction may be very different in these armatures, as well as the ratio between the external diameter and central opening. If we take the latter as ·4 of the diameter, the ampere-turns are 1,900 times the radial depth of the core, in centimetres.

TABLE III.—*Loads Carried by Drum Armatures.*

—	Name of machine.	Diam. of armature core in cm.	Ampere-turns on armature.
	DYNAMOS.		
1	Edison, No. 4	16·0	8,440
2	Edison, No. 5	18·0	10,330
3	Weston, 6 M...............	18·75	10,488
4	Weston, 6 W.I...........	18·8	11,200
5	Weston, 7 M...............	21·8	16,400
6	Edison, No. 10............	24·3	13,150
7	Edison, No. 20..	24·3	17,260
8	Edison-Hopkinson	24·5	13,200
9	Siemens........	29·2	17,600
10	Westminster...............	39·4	22,000
	MOTORS.		
11	Immisch	14·6	7,600
12	Immisch	17·2	9,000
13	Immisch	24·8	14,700

9. MAGNETISING FORCE REQUIRED TO COMPENSATE THE BACKWARD INDUCTION.

The weakening of the field by the current flowing in armatures wound on the Hefner von Alteneck principle has been studied by Drs. J. and E. Hopkinson, but from the fact that the lead upon which the weakening depends is in Gramme-wound armatures much greater, and to a large extent indeterminate, it follows that, in designing, some approximate rule must be employed to fit the types of machines in which these are employed. We may estimate the effect of weakening in two ways: first, we may excite the magnets with a constant current, and measure the fall of E.M.F. due to the armature current; or, secondly, we may, by increasing the magnetising force, keep the E.M.F. up to the same value when a current flows as when the machine is working at no load, measuring the ampere-turns required to effect this compensation. The latter is the proper course to adopt, since, having pre-determined the magnetising force required for the induction in the armature at full load, on the assumption that there are no disturbing reactions, we wish to know what addition is to be made to the force so determined. The weakening of the field is much greater in cylinder than in drum machines, owing to the greater lead required to obtain a sparkless collection; accordingly, the magnetising force necessary to compensate the backward induction must be greater for cylinders than for drums. Its actual value depends, necessarily, on several things besides the ampere-turns on the armature, such as the degree of saturation employed, the ratio of armature to field section, the shape of the pole-pieces, and the magnitude of the stray field. The particulars relating to the degree of saturation, the sections, stray field, etc., of the Phœnix machines have already been given, and from actual practice we find that there has to be added to the magnetising force, in order to compensate the backward induction in these machines, ·33 of the ampere-turns on the armature. By the ampere-turns on the armature is meant, as already stated, the product of the number of external conductors and half the total current. This is for a single horseshoe machine. If there is a divided magnetic circuit constituted by two horseshoes, with their like poles butting, the number of ampere-turns here given has to be wound on each horseshoe.

I have met with some very curious rules for determining the compensating turns. These generally take the form of adding to the magnetising force determined for the required induction at full load such additional ampere-turns as will increase the induction about 5 per cent. It is assumed that at full load the E.M.F. will be as desired, the 5 per cent. extra being for compensation. This method is, of course, incorrect, for the magnetising force added should be for a given machine some function of the armature windings. I believe that for most Gramme-wound machines the value of the compensation coefficient here given will hold good. The compensation coefficient for drum machines I have not yet been able to determine.

10. TOTAL MAGNETISING FORCE.

To the magnetising force required for a simple magnetic circuit, as given in 1, we have to add the force required to compensate the backward induction, as given above. The equation for the magnetising force now becomes for cylinder machines

$$A_1 = L\,f\left(\frac{N}{a}\right) + L_1 \cdot 8\,\frac{v_1 N}{a_1} + L_2 f\left(\frac{v_2 N}{a_2}\right) + L_3 f\left(\frac{v_2 N}{a_3}\right) + \ldots + \cdot 33\,A_2,$$

where A_2 is the number of ampere-turns on the armature.

If the machine is to be shunt-wound, and N is the induction corresponding to the E.M.F. at full load, A_1 gives the ampere-turns on the shunt. If it is to be compound-wound, and N is the induction at full load, A_1 is the number of ampere-turns on the series and shunt windings added. The ampere-turns for the shunt alone are obtained by substituting for the induction at full load the induction on open circuit, the armature coefficient being, of course, here omitted. As a matter of fact, the value of v_2 increases between 0 load and full load, but for reasons already given this may in the calculation be neglected.

If the series coils are connected in series, to get the number of compensating turns on each horseshoe we have only to multiply the external conductors on the armature by ·165. It may be mentioned in passing that in the Phœnix dynamos the total series convolutions for ordinary compound machines are uniformly ·31 of the convolutions on the armature; this, multiplied by the current, being the magnetising force necessary to overcome the resistance of the armature and the series coils, and to compensate the backward induction. It will thus be seen that rather more convolutions are required for the latter purpose than for the former, and I think that in most dynamos of medium size the relation is very similar. The only extraordinary relation I know of is in the Victoria machine, where the compensating turns, instead of being a little greater than the turns required to overcome the resistance of the armature and series coil, are three times as great.

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* Paper read before the Institution of Electrical Engineers, Feb. 20, 1890.

11. Working Temperature.

The ultimate rise in temperature of coils wound with double-cotton-covered wire, varnished on the exterior, is, approximately in degrees centigrade,

$$C^0 = \frac{W\,355}{S},$$

where W is the rate at which energy is dissipated in watts, and S the cooling surface in square centimetres. If, for the latter, we substitute square inches, S_1, the equation is

$$C^0 = \frac{W\,55}{S_1}.$$

The coefficients have been obtained from practice, but they are liable to some uncertainty. In the cases from which they have been derived the coils were wound on formers of sheet iron, which fitted close to the magnets. These formers were fitted with brass end flanges, and in the spaces between the flanges and the wire, also between the body and the wire, was a thick layer of insulating material. The surface of the end flanges is not included as making up S or S_1, nor is the inside surface of the former next the magnet. Though insulated so well thermally, there is certainly a flow of heat towards the interior of the magnets and towards the end flanges, so that, as a matter of fact, the virtual cooling surface is greater than given above. Its value it is, however, difficult to determine, while the above equation is approximately true for machines of medium size, and may be used for all cases in which the coils do not exceed 2½in. or 3in. in thickness.

For armatures—which in rotating induce a current of air—the equation is different, and the coefficient given above may have a much lower value, according to the velocity and ventilation. For armatures the surface velocity of which is 50ft. per second (3,000ft. per minute), and the exterior diameter of the core 1½ times the interior, the length being about equal to the diameter, the rise is, approximately,

$$C^0 = \frac{W\,225}{S},$$

or

$$C^0 = \frac{W\,35}{S_1},$$

accordingly as the surface is taken in square centimetres or square inches. Here the whole of the cooling surface inside, outside, and at the ends is counted, W being the total watts dissipated in both electrical waste and hysteresis. The latter must, under no circumstances, be neglected, as it may reach 20 per cent. or more of the total. In giving the above equation it should be stated that the armatures of the machines which furnished the results are closed at the commutator end, except at the periphery, where a draught of air through the centre from the pulley end is expelled. For slow-speed machines the coefficient is necessarily higher, and a larger surface must be allowed, or special means adopted, in the shape of vanes or blades, to force a draught through the armature. Experience can be the only guide here.

Considerable difference of opinion exists with reference to the temperature rise which should be permitted in dynamos. The rise of about 11deg. C. allowed by the Admiralty is admitted by all engineers to be absurdly low; while, on the other hand, the machines sent out by some manufacturers get at their normal output dangerously near the temperature at which the insulating material would become useless. We have to steer between these two extremes, working far under the critical temperature, but, at the same time, not making machines too costly on account of the excessive surface allowed. It will be observed that from the manufacturer's point of view the settlement of this point is of great importance, since a competitor, by allowing a greater temperature rise, may put in a machine of less weight, and therefore less costly, though not necessarily less efficient.

In any case, the ultimate temperature of the machine ought not to rise above a certain value, whatever the temperature of the room in which it works. In my opinion, an ultimate temperature of from 70deg. to 75deg. C. may be permitted with perfect safety, but this should not be exceeded. Independently of the ultimate temperature, the rise in working should not be too great, and, accordingly, we have in the Phœnix dynamo fixed this limit at from 30deg. to 35deg. C. Machines working in atmospheres up to 35deg. C. have a cooling surface, therefore, which will give in continuous working a rise of 35deg. C.; when the temperature is higher the cooling surface is increased, so that the maximum temperature does not exceed 70deg. C., the limit given. It will be seen from the formula that for a rise of 35deg. C. in the magnets, the cooling surface is 10 square centimetres (1·56 square inches) per watt.

For armatures having the proportion stated, the surface requires to be about 7·3 square centimetres (1·13 square inches) per watt; but here it is less easy to formulate rules. Both interior and exterior surfaces are ventilated by the motion, the former generally being of a broken character, which aids the cooling. The temperature of these surfaces does not measure the temperature of the bottom layers of wire or of the armature core itself, and when I speak of a temperature of 70deg. C. I mean, of course, that of the hottest part. The difference of temperature between the interior of the core and the outside surfaces, in a machine of given carcase dimensions, depends on the gauge of wire with which the armature is wound. Obviously, the difference of temperature required to produce a given flow of heat depends upon the thermal resistance encountered, and, therefore, on the number of layers of badly conducting substance, in the shape of cotton covering, through which the flow takes place. For this reason an armature wound with one layer of coarse wire requires a less cooling surface per watt to keep down the internal temperature than an armature wound with fine wire, even if the mass of copper is similar. In practice, allowance for this is made by working the small-gauge wires to a less current density. On account of the flow of heat being obstructed by badly-conducting substances, armatures with cores constructed of wire always get hotter inside than those with plate cores.

Of course, it will be understood that the coefficient given for the rise of temperature will be greater for those armatures in which the central opening in the core is less than two-thirds of its external diameter. Where, for instance, it is half the external diameter, the inside radiating surface is diminished to three-fourths of that specified, and the temperature rise will be proportionally higher, unless a stronger draught of air is sent through the centre of the armature.

12. Load Diagrams.

A dynamo having been completed, its performance should be recorded in such a manner that we shall be able to tell at a glance what a machine of similar carcase dimensions will under any circumstances give. First, the machine is run on open circuit, and the relation between the ampere turns on the magnets and the E.M.F. established. In Fig. 20 the curve, A B, shows this, abscissæ giving ampere-turns, and ordinates the E.M.F. While running at the same speed, take the greatest permissible current from the armature, and, keeping this constant, take observations of the magnetising force and E.M.F., the field being weakened down step by step until it is just possible by adjustment of the brushes to run without sparking. For each reading the brushes will have been adjusted to the sparkless position, and the curve expressing the relation between the magnetising force and E.M.F. when the maximum current flows may be plotted as at Q H. The curve stops at H, because with a further weakening of the field a non-sparking position cannot be obtained. Repeat the experiment for a less current in the armature than for a smaller still, until there is a series of curves—Q H, E F, C D—as shown, representing the relation between the magnetising force and the E.M.F. for several different values of the ampere-turns on the armature. It will be observed that as the ampere-turns on the armature get less, the curve can be carried lower, or, in other words, we can weaken the field to a greater extent before arriving at the sparking point.

This load diagram tells us everything we wish to know about the magnetic circuit of a machine having these particular dimensions, and about the interference of the armature on the field circuits. It tells us the ampere-turns required for any induction on open circuit, or, in other words, the magnetising force required for the shunt only if the machine is to be compounded; it tells us how many ampere-turns must be added to raise the E.M.F. by a required amount with any current flowing, or to compensate any armature load; it tells us how we can over-compound the machine; and, lastly, just how far we can weaken the field for any load without producing sparking. That we can by its aid calculate with accuracy the windings of any machine which requires the same carcase, will be sufficiently obvious without farther explanation.

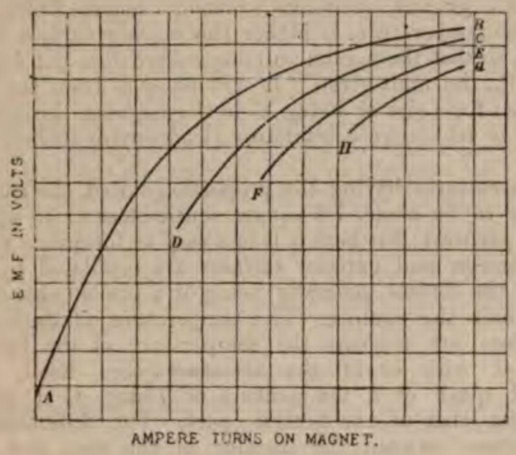

Fig. 20.

13. The Best Relation Between the Iron and Copper in the Armature.

It is of some importance to know the best relation between the thickness of the iron core and the depth of the winding which will give in armatures the best results for given dimensions. Suppose we have a cylinder armature of certain radial depth over the winding: while keeping this depth the same, we may vary the iron and copper of which it consists within wide limits. The question is, what relation of copper to iron will give the best results, premising that, however the relation is varied, the temperature shall remain the same. The cooling surface we will take to be unaltered, and this means neglecting hysteresis—for a reason given presently—that the heat generated in the winding shall be constant. Since the waste is constant, the point of maximum efficiency coincides, then with that of maximum output. If the copper on the outside of the armature is considered as a shell of t thickness, we may, within the limits of our enquiry, take the current that may be carried to generate the same heat $= \sqrt{t}$. The E.M.F. produced will be proportional to the radial depth of the armature core, r, and assuming in each case the same degree of saturation, the greatest output for a given radial depth of armature is obtained when $r \sqrt{t}$ is a maximum. This occurs when the exterior layer of copper is about one-fourth the depth of the armature core, the output for different proportions between iron and copper being shown by the curve, Fig. 21. In the diagram the base line, A B, represents half the radial depth of the armature over the winding, distances measured from left to right giving the thickness of the exterior shell of copper. The ordinates represent the output. A dotted line, C D, is erected at the point of maximum. It may be assumed, without any great error, that the weight per unit length of circumference is constant, however the proportions vary, so that the curve may be taken to represent maximum output for a given weight as well as for given dimensions. With a square or bar winding this is about correct.

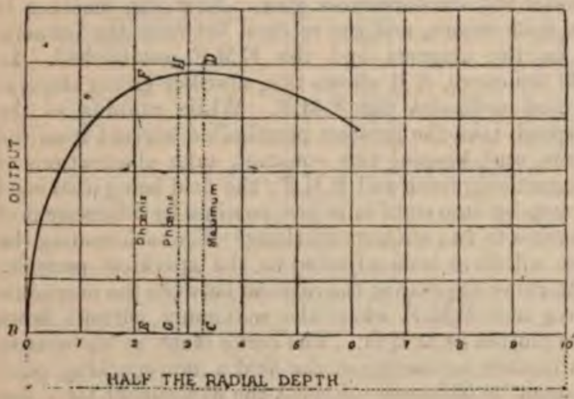

Fig. 21.

It will be observed that the relation of copper to iron can be varied considerably without making much difference to the output. An armature, for instance, in which the core is six times the thickness of the copper, gives the same efficiency as one in which the relation is 2·75, and the output is in each case only 3 per cent. below the maximum. The relation for greatest efficiency is quite independent of the degree of saturation to which the core is carried, or the temperature at which the machine is worked.

The effect of hysteresis is to reduce the height of the ordinates, and to displace the point of maximum efficiency to the right. The current which can be taken from the armature is a little greater than $\sqrt{t}$, on account of the heat from hysteresis diminishing as the core is reduced in thickness. But imagining that in all cases the core is saturated to the same degree, the difference in the amount of heat generated from this source is, within the limits of practice, so small a percentage of the whole that its effect on the shape of the curve may be quite neglected.

Machines are not always designed so that the proportions give maximum output, since other considerations arise besides that of the best result from the armature considered by itself. The question of magnetising the core has to receive attention, and the question is resolved into, what is the best proportion for the machine, considered as a whole? The answer to this depends entirely upon the design. In the Phœnix dynamos we work between the limits given by the two vertical dotted lines, E F and G H, in Fig. 21, finding that there we obtain the best results. If we worked to the right we should get a greater output, we should have a greater air gap, a diminished flux through the armature core, but, on account of the increased stray field, about the same flux in the magnets. The magnetising force and the compensating turns on the magnets would be increased somewhat, while the cross induction would remain about the same. As regards this last point, it is worthy of note that the tendency to sparking, with the usual clearance spaces, remains about the same for considerable variation in the proportion of copper to iron. Increasing the copper does not increase the length of the air gap in the same ratio, but in a ratio rather greater than $\sqrt{t}$, or than the current which can be taken from the armature. At the same time the radial depth of the core is diminished, the final result being that $\frac{A_2 w}{l r}$ is about constant within the limits of practice.

For drum armatures the relation for maximum output can be similarly determined, and similar conditions fix the limit of departure from the maximum. One point with reference to these considerations should be noticed, and that is, that neither for cylinders nor drums does the point of maximum efficiency or output coincide with the point at which $\frac{\text{watts}}{\text{weight of copper}}$ or $\frac{\text{volts}}{\text{yards of copper}}$ is a maximum, and that these ratios, as applied to compare the performance of dynamos, are accordingly misleading. Given a limiting temperature, the only factors upon which the commercial value of machines should be based are cost and commercial efficiency. Whether the magnets shall be made of wrought or cast iron, whether there shall be a large amount of copper or a small amount, are questions for the manufacturer to decide. In some cases it may pay him to increase the copper and use cast iron, in other cases diminish the copper and use wrought iron. But the finished product is to be judged by its cost to purchase and its cost to run.

14. Motor-Designing.

These considerations naturally bring us to the subject of motor-designing, about which there has been expressed from time to time a good deal of difference in opinion. From the preceding section it will be perceived how far we can go in the direction of getting an increased output from a given weight of armature; and it will have been understood from section 4 that with somewhat lighter field-magnets and a reduced saturation in the armature, a larger yield can be obtained for the total weight, though smaller for the weight of the armature itself. As a general rule, the question of weight does not enter into dynamo designing, except in so far as cost is affected, and a lighter machine means a somewhat increased cost for the output. But in motors it is sometimes necessary to keep the weight as low as possible, and the point to be emphasised here is, that in designing light-weight motors we proceed upon lines precisely similar to those adopted in designing light-weight dynamos.

It has been asserted that in motors the armatures ought to be larger compared with the field-magnets than in dynamos, and by "larger" must be meant either that the armature cross-section is greater, or that the ampere-turns on it are more numerous. As regards the former, it has been shown in section 4 to what extent the relation between the cross-sections of the armature and fields influences the dynamo, and the same reasoning applies to motors. As regards the latter, curiously enough, the examples which I have given in Tables II. and III. show no overloading, but about the same number of ampere-turns is carried as by dynamo armatures, a fact which does not favour the "large armature" school. My own experiments with series machines, in which the brushes had equal lead and trail when running as dynamo and motor, seem to show that the difference in the E.M.F. generated under these two circumstances is negligible. In Table IV. are given the results.

Table IV.—*Series Machines run as Generator and Motor.*

Machine.	Revolutions per minute.	V_1.	V_2.	C.	V_1+CR.	V_2-CR.	Diff.
		GRAMME ARMATURE.					
Phœnix........	820	58	136	12·0	98·00	96·00	– 2·00
	1,700	134	168	5·0	150·60	151·30	0·70
	1,880	136	168	4·5	151·00	153·00	2·00
		PACINOTTI ARMATURE.					
Phœnix.........	820	47	80	4·5	63·00	64·00	1·00
	940	58	96	5·0	75·30	78·70	3·40
	1,295	87	130	6·0	107·70	109·30	1·60
	1,430	104	152	6·75	127·30	128·63	1·26
	1,520	106	158	6·75	131·13	132·87	1·74
		BURGIN ARMATURE.					
Bürgin	500	16	116	14·0	64·67	67·40	2·73
	640	36	130	12·5	79·46	86·54	7·08
	720	60	98	4·25	74·11	83·89	9·78
	780	59	138	10·0	93·77	103·23	9·46
	830	66	142	9·0	97·30	110·70	13·40
	840	72	118	4·5	87·00	103·00	16·00
	860	70	144	8·75	100·40	113·60	13·20
	1,100	104	152	4·75	119·77	136·23	16·46
	1,180	114	164	5·0	130·60	147·40	17·20

V_1 = Difference of potentials at terminals as generator.
V_2 = Difference of potentials at terminals as motor.
C = Current, in amperes.
R = Resistance of machine in ohms.

The cores of the Gramme and Pacinotti armatures were constructed of iron washers separated from each other by paper; while the Bürgin armature consisted of a series of hexagonal rings made of iron wire, each forced on to a six-armed gunmetal spider. The small differences in the last column may be readily accounted for in the case of the Gramme and Pacinotti armatures by errors of observations, as several things had to be measured simultaneously; but no allowance for errors can account for the difference in the case of the Bürgin machine. I talked over these experiments at the time with Mr. Kapp, who suggested that the difference might be due to parasitic currents arising from imperfect lamination, the forcing of the hexagonal rings on the spiders bringing the wires of the core into actual contact at the corners. When the currents are flowing in the same direction through the machine, the armature rotates, with reference to the field, in the opposite direction of course as generator and motor. Now, apart from the question of parasitic currents, with an irregularly formed armature like the Bürgin—and the Brush with its eight or twelve projections would come in the same category—one is not surprised at a difference in the E.M.F., the wonder would be if the direction of rotation did not alter the field. But with a Pacinotti ring in which the slots are many and close together, the influence on the field is slight, and with smooth Gramme armatures the field is not affected by the direction of rotation at all, so we get the same E.M.F. produced as generator and motor.

It must be remembered that the effect of the armature current on the field in cylinder machines is by no means small, as will have been observed by the number of compensating turns required to neutralise it. A machine having 13,500 ampere-turns on its armature would have about 20,000 on its field-magnets, out of which about 4,500 are compensating turns. I mention this to show that the results in Table IV. were not obtained from machines in which the armature effect was negligible, or anything approaching it. The saturation of the core was about 17,000 C.G.S. units.

If a machine is run at the same speed as dynamo and motor, provided the currents in the fields and armature are similar, it will always have a higher efficiency as a motor. If E is the E.M.F. generated by the machine, C the current (imagine it series-wound), and R the resistance, the electrical efficiencies as dynamo and motor are in the ratio of $\frac{C\ E - C^2\ R}{C\ E}$ to $\frac{C\ E}{C\ E + C^2\ R}$, the latter being the greater quantity. If we designate all the other losses save that due to the resistance by p, then for the commercial efficiency we have $\frac{C\ E - C^2\ R}{C\ E + p}$, and $\frac{C\ E - p}{C\ E + C^2\ R}$. If p had the same value as $C^2 R$, the efficiency of dynamo and motor would be similar; but since p has always a lower value than $C^2 R$, the motor has still the advantage.

15. Constant Potential Motors.

Now, as regards another thing which we have been told sometimes—that the armature and magnet fields are added in a motor—so far is this from being the case that, under the usual and proper condition of a trail on the brushes, the weakening of the field due to the current in the armature may play a most important part in the governing of motors at constant speed. In an article contributed to the *Electrician* in 1886 I hinted at this, saying: "By reason of the current in the armature reacting to weaken the field, does not a shunt motor contain within itself the germ of self-regulation, which by suitable proportion may be made effective without a series coil at all?" Since that date motors have been constructed in which the truth so foreshadowed has been realised.

As already stated, the E.M.F. of a separately excited dynamo is represented by an inclined line, C D, Fig. 15, the inclination showing the weakening of the field produced by the current in the armature. Run as a motor, with a trail equal to its lead as a dynamo, the E.M.F. generated—called in this case the back E.M.F.—will be the same, being greater, therefore, as the current is smaller, and smaller as the current is larger. A shunt motor connected to mains at a constant difference of potentials has its magnets excited by a constant current, and the back E.M.F. varies in this way. Its value, calling E_1 the difference of potentials at the mains, is $E_1 - C\ R$, and it is, of course, proportional to the induction through the armature and the speed. Generally we require the latter to be constant, so we write—

$$n \propto \frac{E_1 - C\ R}{N_1}$$

where N_1 is the resultant induction through the armature due to both fields. As we have seen, N_1 is not a constant. There is a weakening of the field proportional to the current, and for N_1 we can substitute a value, $N - f(C)$, where N is the induction on open circuit, and f (C) that function of the current which represents the weakening effect. Writing

$$n \propto \frac{E_1 - C\,R}{N - f\,(C)},$$

it is perfectly obvious that if C R bears the same relation to E_1 as f (C) bears to N, the speed, n, will be constant, and quite independent of the load. Referring to Fig. 15, the height, O C, may be taken as representing the induction when the motor is running with no load, the sloping line, C D, giving the induction for various currents in the armature. The horizontal line, C E, will represent the induction due to the field-magnets alone, and also the difference of potentials at the mains. If the speed be constant, the length of ordinates between C D and C E represents f (C), and also C R. We see clearly that if the induction is diminished without a proportional reduction of the back E.M.F. the speed will increase; while, on the other hand, if the back E.M.F. goes down without a corresponding decrease in the induction, the speed will be reduced. If it is found that the speed increases as the motor is loaded—and I have seen this—the field must be strengthened, and the turns on the armature reduced, or the armature resistance increased. If the speed gets less, an opposite course must be taken. A shunt motor, then, will run at a constant speed on a constant-potential circuit without compound winding or any other device, if the armature field and magnet field are properly proportioned. A position can generally be found for the brushes where the sparking between the load limits is inappreciable, and the motor may be then trusted with perfect confidence to run at a constant speed.

It must not be thought that because a motor transmits power, it is necessary to manipulate electro-mechanical equivalents until we get torque in pound-feet or foot pounds per revolution, or some other mechanical quantities. This is only a waste of time. In designing a motor we know the horse-power or watts to be given off on the brake at a certain speed, and if we make the machine run at the proper number of revolutions, and in acordance with the conditions of electrical supply, the torque will come out all right without our troubling about it. Suppose we require W watts to be given out on the brake by a motor working on a constant-potential circuit. The power which must be converted in the armature is greater by a certain amount, p, absorbed in friction of journals and brushes, magnetic friction, and parasitic currents. This amount can be foretold to a certain extent, but may be derived from experiments made with machines of the same kind. The power converted being, then, $W + p$ watts; the back E.M.F. being settled as determined by the waste allowable in the armature, the current $= \frac{W + p}{E}$ is obtained; the procedure in design now being exactly as for a dynamo to give a current of $\frac{W + p}{E}$ amperes by E volts at the same speed. If these conditions are fulfilled, the torque may be left to itself.

16. Constant-Current Dynamos.

There seems to be an impression that dynamos for high differences of potentials cannot be worked successfully with Gramme commutators, the reason for this opinion being, I suppose, the breakdown of some imperfectly-constructed machines. That there is no difficulty with the insulation between the conductors and armature core is obvious from the fact that high-potential alternating-current machines are working successfully with armature sections similarly disposed. The fault appears, therefore, to have been solely with the commutators. I need only reiterate the remark I made here a short time ago, that there is no difficulty whatever in constructing Gramme machines up to 1,000, 1,500, or even 2,000 volts, provided the designer knows what he is about. Many such machines are to be seen in daily work. Mr. Bogue, of New York, gives me particulars of a Wood dynamo manufactured by his company which gives 9·6 amperes, and a difference of potential of 2,640 volts at its terminals; Mr. Henrion, of Nancy, constructs Schuckert machines of 1,000 volts; Messrs. Immisch and Co. have constructed motors as well as dynamos of 1,000 volts; while Messrs. Paterson and Cooper have a large number of machines running at voltages varying from 800 to 1,500. The latter run without sparking at the brushes, and with perfectly smooth commutators.

Several attempts have been made to compound machines for constant current, all of them uniformly unsuccessful. It is beginning to be realised that, Deprez notwithstanding, it cannot be accomplished, and during the next six years the equations for constant-current compound winding may finally disappear from our text-books. But it may take longer.

The method of regulation about which I have to make a few remarks is that of rotating the brushes on the commutator, which has proved very successful in some of the machines to which it has been applied. You need scarcely be reminded that if a series-wound machine is directly belted to a separate engine, the combination is almost self-regulating, such small correction as is required being easily effected by a solenoidal electrical governor. In such cases the speeds of both engine and dynamo vary as the E.M.F., but generally this arrangement is not permissible, in consequence of several machines being driven from the same countershaft; accordingly some device for regulating at constant speed has to be adopted.

In machines in which the current is variable we endeavour, as I have said, to make the self-induction as small as possible, and we work with the brushes somewhere between the polar tips where the field is almost neutral, or only of strength sufficient to overcome the slight effect of self-induction, and bring the current up to its normal value before the section leaves the brush. In constant-current machines we work always in the active field under the pole-pieces, and to prevent the flow of an enormous current in the section short-circuited by the brush, considerable self-induction has to be given. Consider an armature in the field, Fig. 16. Opposite the parts marked N and S the induction through a section is *nil*; at A and B it is 16,000, 17,000, or 18,000 C.G.S., as the case may be—that is in the machines we have been speaking of hitherto. If we had here a uniform distribution of field over the poles, an attempt at constant-current regulation by movement of the brushes would only result in sparking, since in every position the back E.M.F. of self-induction is different. If the induced E.M.F. were in one position balanced by the E.M.F. of self-induction, in other positions it would be over-balanced or under-balanced. Another point is, that if regulation is attempted by working with the brushes partly between the polar tips and partly under the poles, the weakening effect of the armature current on the fields is subject to great variation; accordingly, the poles should be extended until the brushes are under them in every position. The essentials for successful regulation will now be apparent. First, the self-induction should balance the field in every position of the brushes; secondly, the poles should be extended so that the brushes in every position of working are under them. An examination of the curve, Fig. 1, will show that up to an induction of 12,000 or so the coefficient of self-induction is, roughly, constant; so that an armature core saturated to this degree would have the same E.M.F. of self-induction for a constant current whatever the position of the brushes. In the Wood dynamo already referred to the induction in the armature is 13,000 per square centimetre, and in the Sperry dynamo, which hails from Chicago, it is about 14,000. Mr. Sperry's remarks I give in full in the appendix, also those of Mr. Bogue concerning the Wood machine. In both these machines the masses of iron in the magnets and pole-pieces are disposed so that the field is fairly uniform over the poles, but this is by no means necessary, provided the E.M.F. of self-induction balances the field in every position. Making the field distribution uniform and the self-induction uniform affords the easiest method, however, of attaining the end in view. It remains only to say that the field at the short-circuited section is greatly reduced in strength by the current in the armature, and that the best number of turns per section must be determined by experiment. It will be evident that the single-magnet type of machine, as illustrated in Fig. 7, is the least suitable for constant current, and while in America they choose the best form of magnet for the purpose right away, in this country the attempts at regulation have been made very often by selecting the worst form and chopping away at the poles until it comes about right.

It is unnecessary to describe the various forms of apparatus for shifting the brushes. Briefly, they consist of a mechanical device, electrically controlled, whereby the brushes are moved forwards or backwards on the commutator as the current rises or falls slightly. Upon the rapidity with which this regulator responds to variations in the current depends the successful working of the machine. If the current is allowed to rise or fall outside a small percentage, the adjustment of the fields is thrown out of balance and sparking results. The importance of having a regulator which is sensitive, and acts with promptitude, will therefore be apparent.

17. Relation of Size to Output.

Great differences of opinion exist about the relation of size to output in dynamos. Prof. Thompson, in his "Dynamo-Electric Machinery," quotes several writers who give the output at figures varying from the square to the fourth power of the linear dimensions, and the subject has been discussed to some extent in this room. Mr. Kapp has worked out the relation, and assuming that in larger machines the space taken up by the insulation is proportionally less, more copper being accordingly got on the armature, he makes the output for a machine whose linear dimensions are increased n times from n^3 to $n^{3\frac{1}{2}}$, the speed being inversely as the linear dimensions. Prof. Ayrton thinks it ought to be higher than $n^{3\frac{1}{2}}$, while Dr. Hopkinson finds that everything considered it comes out about n^3. With the single exception of Dr. Hopkinson, I am not aware that anyone has mentioned the consideration which, above all, determines this relation, that is, the interference of the magnet and armature fields.

(To be continued.)

ELECTRICITY AS APPLIED TO MINING.*

BY E. J. FOORD.

It is here intended to consider the advantages that may be had from electricity as applied to quartz mining.

Reefs in Otago have now been worked for 23 years, and in more than one instance almost continuously, so that a fair average estimate of their permanence and value ought to be arrived at by reviewing the work done and results obtained during the past. Quartz reefs are being worked in Auckland, Marlborough, Nelson, Westland, Canterbury, and Otago, and are thus proved to occupy the whole length and breadth of both islands. The average value of gold saved from each ton crushed is £2. 12s. 6d., this being a 20 years' average. Mr. G. P. Hilton, a mining expert of ability, states that in some cases from 2dwt. to 3dwt. per ton should pay. If this were the rule it would give a profit of 42s. per ton on the stone crushed on the above average. Experience shows, unfortunately, that it is anything but the rule. An opportunity has been afforded me to arrive at what a ton of quartz costs to get and crush from three separate mines in different provincial districts—Otago, Westland, and Auckland—the following being the ruling rates : Wages—Miners, 10s.; grass men, 9s., truckers, 7s.; battery hands, 54s.; boys, 30s.; mine managers, 133s.; horse feed, 15s.; timber, 20s.; coal, 55s. The total cost per ton comes to 30s. 3d., made up as follows : Breaking, 9s.; tools, 4d.; fuse and dynamite, 2s. 3d.; timber, 4s.; trucking, 8d.; carting, 1s. 3d.; crushing, 8s. 8d.; light, 2d.; management, 2s. 2d.; interest on paid-up capital, 1s. 9d. No separate account being kept of proportion of timber, tools, dynamite, and management for prospecting, pumping, and general up keep, this return does not give a basis to work from. The cost per ton would evidently greatly lessen if the output was increased. The cost for management, crushing, interest on capital, etc., would be but slightly increased if three times the quantity, which is 248 tons per month, were dealt with. It is in this direction we must look if our reefs are to become of value to shareholders. One pound a ton profit is not of any value when only 200 tons are crushed for a season's work. Let the mine crush 5,000 tons per year regularly, and it becomes what its name implies—a veritable gold mine. In a reef 3ft. wide, 62ft. must be driven out per week to supply this amount, and four stopes or headings kept continuously at work. This, in ordinarily hard ground, means 24 miners, three truckers, three breaksmen, 12 men opening out or sinking on new ground, with as many more for battery and other purposes. The outgo would be £800 per month, with the average return of £2. 12s. 6d.; £13,125 would be got, and dividend of 35 per cent. earned, on £10,000, the capital probably required.

At Nenthorn the average width of the reefs is much less than 3ft., but the returns show over 1½oz. to the ton. At the head of Lake Wakatipu the average is 5dwt., but the width is from 4ft. to 14ft. In both cases only by greatly increasing the output can the claims become of any value to shareholders. While at Macetown a note was taken of the cost of getting out 100 tons of stone. Day labour was employed, and the best of miners, who worked as only miners can work when on the job. The wages came to £31, steel 4s., coal 25s., timber 43s., powder and fuse £3. 6s., incidentals £2. 7s., equal to 8s. per ton.

With the mines opened out and overhead stopping adopted any required quantity of quartz could be gained at the same price by contract. The various companies only require a preliminary outlay of from £2,000 to £3,000 in opening out and erecting crushing plants at or near their tunnels. They should have only the best of ore-saving appliances, which will save not only the free gold, but all the pyrites as well. Until it is recognised that quite 25 per cent. of the gold in our reefs is at present lost by amalgamation no permanent progress will be made in this direction. If the School of Mines would establish a works for the treatment of pyrites, and every reef save all their minerals in a concentrated form, and send it for treatment to such an establishment, much good would be done alike to the pupils of the university, the mine owners, and the country. In one case known to the writer 1oz. 16dwt. of gold per ton was saved by the battery process, and a report received from an analytical expert that 11oz. 8dwt. were lost per ton of pyrites. The quantity in the quartz was not known.

At Macetown, a district almost deserted as a quartz mining centre, an average of over 17dwt. has been given, yet there are only two mines at work. Were this district in Victoria there would be 20 mines in full operation, each employing over 50 hands, for with the exception of Reefton it is one of the cheapest places in New Zealand to carry on quartz mining, want of timber being the only drawback. This is, however, more than compensated for by no steam or pumping plants being necessary.

With electric power plant in the Twelve Mile or Arrow river every mine at Macetown, including the celebrated Tipperary, could have crushing, drilling, and light supplied directly at the point required, saving all cost of tramway or haulage, and also saving 33 per cent. of the present cost of driving entailed by the use of power drills. In hard ground by hand drilling, using 1in. steel with three men—viz., two hammerers and one turner—the cost per foot of hole averages 3s., which includes cleaning and firing. A mine employing nine men all the year round in opening or prospecting new ground has to pay £1,012 for drilling alone. It may be considered a good average if 1·33ft. per man per week is driven—say 600ft. per year for this number of men, and the cost comes out as follows : Dynamite and fuse, £270; rails and sleepers, £90; ventilation, £15; steel, coal, incidentals, £17. 10s.; wages, £1,350, equal to £2. 18s. per foot. An electric drill is now in use weighing 100lb. It will bore the hardest antharacite or quartz rock at the rate of 30ft. per hour, at a cost of 2½d. for power. Using these drills, the cost for 600ft. of tunnel in hard country would probably not be more than £1. 19s. 6d. per foot, saving £600 and six months' time. Prospecting and driving new levels are in most cases dead work, and a saving of 33 per cent. is an item no mining company can afford to ignore, while to the workman it means much less laborious and more constant work. In the case of the Tipperary immediate and certain returns could be had with a very moderate expenditure—probably not more than £5,000 ; and a delay of two years' time could be avoided, and at least 1,000ft. more in depth could be worked from the present shaft site. The New All Nations, Garibaldi, Maryborough, and Homeward Bound mines are all known to be payable under favourable conditions ; yet at present they are only held on sufferance, no capital being available to properly develop them.

As many of the reefs in this district carry large quantities of mineral, a heavy percentage of gold has been undoubtedly lost, for every battery manager knows that this class of quartz makes the silver sicken much more quickly than when clean stone is crushed. By using sodium amalgam this is to a greater or less extent prevented, for the sodium decomposing water forms caustic soda, NaHO, and setting hydrogen free the hydrogen in its nascent state has its power greatly increased, and seeks to combine with sulphur, oxygen, or arsenicum, to form compounds that are carried off by the water. By using an electrical current of low electromotive power the same effect is produced in a constant and regular manner without cost beyond that for the power to drive the dynamo. The beneficial effects are amply demonstrated by Mr. E. S. Bennett's letter and my own experiments. When, however, sulphide of antimony occurs in any considerable proportion in the quartz this treatment is of no use, and would probably exaggerate the evil it is intended to cure, for it would help the silver to form an alloy with the antimony. Sulphuretted hydrogen would tarnish both gold and silver, and prevent their metallic contact, by which means amalgamation takes place.

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* Abstract of an article contributed to the *Otago Witness*, early proofs of which have been sent by the author.

It is impossible to save all the gold contained in pyrites by any process of grinding and amalgamation. Grinding has certainly the effect of cleansing a portion of the contained gold, but to save nearly all it is necessary to roast and decompose the sulphides entirely.

At Widnes depositing dynamos have recently been supplied by Elwell-Parker to the extent of 1,000 h.p. for copper refining. The process is far cheaper than the ordinary method, costing only 10s. per ton. The oxides are cast into plates 2in. thick, which are used as anodes in a depositing bath of sulphate of copper, pure copper depositing—all impurities, together with all the precious metals, settling as sludge. Fifty-six tons of pure copper per week are deposited by these dynamos.

(To be continued.)

CITY NOTES.

Western Union Telegraph Company.—This Company has declared a quarterly dividend of 1¼ per cent.

Great Northern Telegraph Company.—The receipts for February were £19,800, making for January and February a total of £39,400.

Western and Brazilian Telegraph Company, Limited.—The receipts for the week ended March 7, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,896.

Brazilian Submarine Telegraph Company.—The receipts for the past week amounted to £5,060. A quarterly interim dividend at the rate of 6 per cent. per annum has been declared by the Board of this Company, payable on the 25th inst.

Companies of the Month.—The following electrical companies have been registered during the past month :—

Farsham Electric Light Company, Limited, £1 shares	£5,000
Mutual Telephone Company, Limited, £10 shares	100,000
Poole and Whyte, electricians, £5 shares	20,000

Direct Spanish Telegraph Company, Limited.—The report for the half-year ended December 31st, after providing for debenture interest, shows a profit of £6,361. The receipts were in excess of those for any previous half-year, and show an increase of £1,592 as compared with the corresponding half of 1888, the working expenses being £690 higher. The sum of £2,500 has been put to the reserve fund, which now amounts to £17,516, and the Directors recommend a dividend at the rate of 10 per cent. on the preference shares, and one at the rate of 6 per cent. per annum, tax free, on the ordinary shares, making with the previous distribution 5½ per cent. for the year, against 4½ per cent. in 1888, £847 being brought forward to meet possible contingencies.

Electrical Engineering Company of Ireland, Limited.—A Company has been incorporated under the Companies Acts, 1862 to 1886, with a capital of £50,000, divided into 24,950 ordinary shares of £2 each, and 100 founders' shares of £1 each, with power for the Directors to borrow to the amount of £15,000. The following are the Directors: Sir Howard Grubb, M.E., Univ. Dub., F.R.S., Kenilworth-square, Rathgar, Co. Dublin, chairman. Thomas Mayne, Esq., ex-M.P., T.C., Williams' Park, Rathmines, Co. Dublin (director Irish Woollen Company, Limited). George F. Fitzgerald, Esq., F.T.C.D., F.R.S., Trinity College, and No. 7, Ely-place, Dublin. William Edward Wilson, Esq., J.P., F.R.A.S., Daramona House-street, Rathowen; Athenæum Club, London, S.W.; Kildare Street Club, Dublin. James H. North, Esq., J.P., No. 110, Grafton-street, Dublin, and Lonsdale, Kingstown, Co. Dublin. David Sherlock, Esq., B.L., Rahan Lodge, Tullamore, and 71, Leeson-street, Dublin. Thomas J. Haslam, Esq. (W. R. Box and Co., and the Central Electrical Engineering Co.), 105, Middle Abbey-street, Dublin, and 2, Belgrave-road, Rathmines, Co. Dublin. E. Garcke, Esq. (of the Brush Electrical Engineering Company), London and Loughborough, Belvedere-road, Lambeth, London. The two latter will join the Board after allotment. The electrical engineer is Arthur E. Porte, A.I.E.E., and the secretary (*pro tem.*), J. Buckley. The consulting engineers are John S. Raworth, M.I.E.E.; R. Percy Sellon, M.Inst.E.E.; W. G. Strype, C.E., M.I.C.E., M.I.M.E. The temporary offices of the Company are at 46, Dame-street, Dublin.

PROVISIONAL PATENTS, 1890.

MARCH 3.

3322. **An improved voltaic battery.** Frederick Keep, 128, Colmore-row, Birmingham. (T. and S. Morrin, Limited, New Zealand).

3329. **Improvements in the manufacture of light emitters or illuminants for electric or other lamps.** James Clegg, Connaught-mansions, Victoria-street, Westminster.

3335. **An improvement in holders for incandescent electric lamps.** Adolf Schirner, 47, Lincoln's-inn-fields, London.

3373 **Improvements connected with the charging of electrical accumulators or secondary batteries.** Marcel Sappey, 166, Fleet-street, London.

3374. **Improvements in electric accumulators or secondary batteries.** George Edward Barker Pritchett, Oak Hall, Bishop's Stortford, Herts.

MARCH 4.

3439. **Improvements in secondary or storage batteries.** Stanley Charles Cuthbert Currie, 323, High Holborn, London. (Complete specification.)

3455. **Improvements in and relating to electric secondary batteries or accumulators.** Henry Harris Lake, 45, Southampton-buildings, London. (Thomas Ewing, United States) (Complete specification.)

3472. **Improvements in apparatus or appliances for operating electrically devices for informing passengers in railway carriages as to the names of stations on the line, or for conveying to them other information.** James Wilson Little, 47, Lincoln's-inn-fields, London.

MARCH 5.

3523. **Improvements in armatures for dynamo-electric machines.** John Nebel, 28, Southampton-buildings, London.

3534. **A new or improved device for extending the circuit of incandescent lamps.** Lancelot Walter de Grave, 37, Chancery-lane, London.

3544. **Improvements in and relating to electric telegraphy.** Francis Jarvis Patten, 45, Southampton-buildings, London. (Complete specification.)

MARCH 6.

3574. **Distributing electricity.** Henry Robert Low and George Edward Barker Pritchett, 64, Tavistock-terrace, Westbourne Park.

MARCH 7.

3622. **Improvements in the manufacture of light-emitters or illuminants for electric lamps.** James Clegg, Connaught-mansions, Victoria-street, Westminster.

3625. **To provide a safer and cheaper insulator that is not liable to be broken and a more ready and safer means for securing the telegraph or telephone wire to the insulator.** James Salter Scales, 8, Albert-road, Tunbridge, Kent.

3654. **Improvements in apparatus or means for supplying, distributing, controlling, and metering electric currents.** Henry Edmunds, 47, Lincoln's-inn-fields, London.

3658. **Improved electrical signal clock.** Julius Steinheuer, 28, Southampton-buildings, London. (Complete specification.)

3660. **Improvements in apparatus for connecting and disconnecting electric circuits.** Samuel Barton McClellan, 33, Chancery-lane, London.

3663. **Improvements in means or apparatus for metering electric currents, applicable also for indicating or recording the electrical condition or charge of secondary batteries and the like.** Henry Edmunds, 47, Lincoln's-inn-fields, London.

MARCH 8.

3697. **Improvements in galvanic cells and batteries.** John Anderson, 70, Wellington-street, Glasgow.

3731. **Improvements in or connected with the positive elements (negative electrodes in charging) of secondary batteries, which elements are applicable also as cathodes in electrolysis.** The Mining and General Electric Lamp Company, Limited, and Desmond Gerald FitzGerald, 47, Lincoln's-inn-fields, London.

SPECIFICATIONS PUBLISHED

1879.

2110. **Electric lighting.** Siemens. 1s. 1d. (Second edition.)

1889.

2472. **Secondary batteries.** Wise (Gibson Electric Company). 8d.
4371. **Electricity meters.** Hookham. 8d.
5844. **Telegraph, &c., installations.** Lodge. 8d.
6171. **Regulating, &c., electric currents.** Heap. 8d.
6568. **Dynamo-electric generators, &c.** Dorman. 8d.
6569. **Dynamo-electric generators, &c.** Dorman. 8d.
6570. **Dynamo-electric generators, &c.** Dorman. 6d.
6572. **Dynamo-electric generators, &c.** Dorman. 8d.
7719. **Electric cells.** Schoop. 6d.
11215. **Telephone transmitters.** Goulding. 8d.

1890.

693. **Electric motors.** Currie. 8d.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Anglo-American Brush	—	2¾
— Pref.	—	1⅞
India Rubber, Gutta Percha & Telegraph Co.	10	18⅞
House-to-House	4½	5
Metropolitan Electric Supply	—	6
London Electric Supply	5	3
Swan United	3½	5
Telegraph Construction	12	45
— 6%, 1889	100	105
National Telephone	5	5¼

NOTES.

Electric Traction.—It is stated that two large firms best known in the electric traction business are about to consolidate.

Harrogate.—The application to light Harrogate with the electric light by the National Electric Supply Company has been withdrawn.

Telephone in Persia.—The laying of the first telephone in Teheran is to be undertaken by the Persian Minister of Commerce.

Japan.—The Westinghouse Electric Light Company, of Pittsburgh, has just closed a contract for lighting a Japanese town with electricity.

Southwark Subway.—Sir Edward Watkin and other directors of the Metropolitan Railway visited the Southwark Electric Railway last week.

Exeter.—At a meeting of the Exeter Electric Light Company it was reported that the company's machinery was now nearly complete, and the demand for the light was increasing.

Electric Traction in Paris.—Four accumulator cars are now running in Paris on the Madeleine-Levallois line. The cost of running is given as 3d. per car-kilometre—about 5d. per car-mile.

Electric Mining.—Mr. Edison and his assistants have taken quarters for a year in Charlotte, North Carolina, to pursue experiments in the mining districts, which are declared to be the richest mineral region in the world.

Institution.—At the meeting of the Institution of Electrical Engineers on Thursday next, 27th inst., a paper will be read on "Alternate v. Continuous Currents in relation to the Human Body," by H. Newman Lawrence, member, and Arthur Harries, M.D.

Central London Railway.—The opposition to the proposed deep-lying underground electric railway along Holborn to the West-end appears to be giving way, in face of the evident advantages of the system and its absence from interruption during execution.

Paris Lighting.—Efforts are being made by M. Sauton and other municipal councillors of Paris to have a portion of the vote of 100,000 francs for improvement of the street lighting of Paris applied to streets on the left bank of the Seine. The system proposed is a mixture of arc and incandescent lighting.

Tramways in India.—An order is published in the *Punjab Gazette* authorising Mr. J. S. Attfield, C.E., to proceed with the construction of a tramway in Rawalpindi. The work is to be commenced within a year. The power to be employed is not stated, but the item may be worth the attention of electrical engineers.

Dr. Werner Siemens.—We are informed that Dr. Werner von Siemens has retired from active participation in the business of Messrs. Siemens and Halske, Berlin, intending to devote himself to pure science. He still remains a sleeping partner in that firm. With regard to his position as chairman of the English firm no change has been made.

Development in Siam.—The country of Siam seems, from recent information which has been published, to be likely to open out as a valuable market for British industries. The King of Siam has granted concessions, and the capital now possesses a telephone exchange and an electric lighting station. The chief hydrographer to the King of Siam is now in London on furlough.

Electric Light and Power.—An interesting lecture was given by Mr. J. Appleton, of Messrs. Appleton, Burbey, and Williamson, before the Guildford Young Men's Association last week, on the subject of "Electric Light and Power." Mr. Appleton had a crowded attendance, with the Mayor of Guildford in the chair, and the lecture, which was illustrated by the aid of storage batteries, was much appreciated.

Blackwall Tunnel.—We notice that Lord Rosebery, at a special meeting of the County Council, advised that tenders for an experimental shaft and the completion of a section of tunnel should be invited, limiting the expenditure to £5,000, to test the possibility of running an iron-lined tunnel under the Thames at Blackwall, similar to that of the Southwark Electric Subway. If such an experiment disclosed insuperable difficulties, the Council could reconsider its position.

Electric Motor in a Play.—An interesting application of electric power has lately been made in a New York theatre. Neil Burgess's "County Fair" was to be played, and in this one of the features was a horse race on the stage. In order to keep the horses before the audience the platform upon which the horses run is endless, kept moving by rollers. When motive power was discussed it was decided to apply a Sprague motor, which accordingly has been installed, and makes a unique application of electricity for stage purposes.

Electric Snow Plough.—A snow plough has been built by the Sprague Electric Company for one of their tracks. It is fitted with two 15 h.p. motors, and is arranged to run in either direction. It is estimated that this electric snow plough will clear the track more quickly and efficiently than an ordinary snow plough drawn by 12 horses. The same company have nearly completed a special electric sweeper and track cleaner, for cleaning the track of dust, dirt, slight snowfalls, and other impediments to the good running of the cars.

French Exhibition.—The idea of holding a Belgian exhibition this year at Earl's Court has been abandoned, and preparations have been advancing for some time for a French exhibition from May to October. The French colony in London are greatly interesting themselves in the project, and considerable support is being given from prominent firms in Paris and other towns. Special features will be made of a grand French fête in the grounds, and of typical French restaurants furnished by the best known Parisian restaurateurs.

Electrical Transmission in Switzerland.—Engineers in Winterthur are actively occupied with the question of electric transmission of power from the falls of the Rhine near Winterthur. It is proposed to establish a power house at the falls which with an efficiency of 75 per cent. will yield 1,500 h.p. It is proposed to use the current both for the driving of machinery in factories and the treatment of metals. The initiative has been taken by the head of one of the best-known works, Herr Sulzer-Steiner, of MM. Gebr. Sulzer, machine works.

Smyrna.—The negotiations for the electric lighting of the city of Smyrna are announced as being in fair way of completion, the administration being now engaged in the consideration of the matter. In event of an arrangement being made, the concessionaire will be required to have ready 400 lights by the 1st May, the date at which the present contract with the gas company expires. Six hundred others—the number being fixed at 1,000—are to be ready by other specified dates. Smyrna has 1,600 gas lights at the present moment.

Presentation.—An interesting ceremony took place at The Reindeer Hotel, Newcastle-on-Tyne, on Saturday, March 8. Mr. J. G. Moon, having resigned his appointment of works manager to Messrs. J. Holmes and Co., electric light engineers, of that city, the employés of the firm, to show their esteem and regret at his leaving, presented him with a very handsome ormolu clock and vases, value £20. We understand that Mr. Moon has accepted the position of works manager to Messrs. J. G. Statter and Co., of West Drayton.

Solar Action on Electric Charges.—MM. T. Elster and H. Geitel have found that pieces of polished metal do not preserve a negative charge of electricity after being exposed to the rays of the sun, or even to the light of day. The positive charge, on the other hand, can be quite well preserved. In a dim light both charges can be kept, and this effect is more sensible for magnesium and aluminium than for zinc. Plates of polished metal exposed to the sun's rays are charged positively. A film of water, or even of mist, on the surface is quite enough to prevent these actions almost entirely.

Gulcher Company.—Mr. G. Binswanger informs us that he has resigned his seat on the board of the Gulcher (New) Electric Light Co., Limited. It will be remembered that at the time of the establishment of the present company most of the creditors of the old company exchanged their claims for shares in the new company, and Mr. Binswanger was elected as a director to represent their interests. Now that the issue of the remaining share capital has been successfully accomplished, Mr. Binswanger considers his task at an end, and wishes to notify to those who reposed their confidence in him of his resignation.

Meter Competition.—The names of the persons to whom prizes have been awarded by the Paris Municipal Council for electric meters were published on March 13. On the motion of M. Sauton, it was resolved to hold a second competition during August next. The following are the awards: M. Cauderay, 2,000f., for his various meters; M. Aron, 2,000f., for his various meters; M. Brillié, 1,000f., for his energy meter; M. Blondlot, 1,000f., for his energy meter; and M. Jacquemier, 1,000f., for energy meter; total, 7,000f. The above-mentioned are open to exhibit in the second competition if desired; this will not be later than August, 31, 1890.

Elmore's Wire.—The Elmore Wire Manufacturing Company has been registered, and an issue of 100,000 shares of £2 each, at a premium of £1 (half of the premium being carried to reserve, and half going to the Elmore Depositing Company), is offered, the list closing on Saturday. The company is formed to manufacture wire for electric and other purposes from copper obtained by Elmore's depositing process. Messrs. Clarke, Forde, and Taylor report the conductivity of the wire to be 102·38, in terms of the standard for annealed copper. The company propose an output of 100 tons per week. The cost of manufacture is stated to be far less than that of the best copper wire now produced.

House-to-House Lighting for Islington.—At a meeting of the Islington Vestry, last Friday, a discussion took place on the report of the Special Lighting Committee with reference to the draft provisional orders sought to be obtained in Islington by the Brush Electric Engineering Company and the House-to-House Electric Light Supply Company. Mr. R. Hammond attended as a representative of the latter Company and explained their system. Eventually the committee's recommendation that the formal consent of the Vestry should be given to the company's provisional order was agreed to, it being at the same time resolved not to approve for the present of a similar order promoted by the Brush Electrical Engineering Company.

Testu Telephone.—This instrument, says the *Bulletin Internationale*, looks almost exactly like a watch, and is chiefly interesting because it has been adopted on the Government telephonic service. In the interior of the case, and screwed to the under side, are two concentric bowls of soft iron, superposed and each with a large edge carrying six sloping pieces disposed symmetrically. They are each furnished with a winding giving a reverse polarity, the outer bowl being a south pole and the inner a north pole. The two coils are connected in series and have a resistance of about 55 ohms. The vibrating membrane is placed above the two electromagnets and forms the upper lid of the box. The inventor of this apparatus, M. Testu, is special agent of the Administration of Posts and Telegraphs.

Sliding Railway.—Sir Douglas Galton's paper on the sliding railway before the Society of Arts cannot but be deeply interesting to all who are occupied with the question of rapid suburban transit. Details of the construction and calculations were given in the paper, and it was stated that M. Barré will erect a short line of the Chemin de Fer Glissant on a plot of land at Neasden granted by Sir Edward Watkin for the purpose. An overhead line is also to be constructed in Paris between the Place Clichy and La Villette capable of carrying 12,000 passengers an hour each way. The distance (about four miles) including stoppages at three intermediate stations, is intended to be traversed in seven minutes. The experimental line exhibited at Paris is to be re-erected at the Edinburgh Exhibition.

Half a Watt per Candle.—We hear, and repeat with a necessary amount of reserve, the report that an incandescent lamp has been brought out, and offered to certain electrical firms, to burn with the expenditure of a half-watt per candle-power, the usual expenditure being now, of course, somewhere about three watts. The statement of watts per candle-power is, by itself, nothing at all, the life at this expenditure giving the other factor. The lamp in question, according to our information, has been tested to 500 hours and was still burning! What practical result may come from this it is impossible to say without further information, but it is evident that a lamp of anything like this small expenditure, especially as shortly lamps can be had at a fraction of their present price, would be well worth burning up in 500 hours for anything like the gain in current energy.

Electric Railway to Archangel.—The following particulars are given of a bold undertaking which is being considered, it is stated, by Russian engineers—the construction of an electric railway from St. Petersburg to Archangel. This railway would connect the Baltic Sea with the White Sea, passing by Ladoga and the Mariask Canal. The project, it is understood, is due to two large firms of Archangel, and is based upon the work of Jablochkoff, Tschikolew, and Siemens. The motive force would be supplied to the train from dynamos installed at the stations along the route. The trains would only contain a restricted number of car riages. It is estimated that the line could be constructed at a total cost of 25,000 roubles per verst (about £3,500 per mile), including the rolling stock, and it is thought that the line will be 30 per cent. cheaper to work than an ordinary railway. When it is remembered that the direct distance proposed is considerably over that from Lands End to John o' Groats, and will be probably 800 to 1,000 miles on the actual route, it will be seen that if the project is being contemplated seriously, it is one of the most extensive yet considered in electrical engineering.

Leamington.—A deputation consisting of the Mayor and the chairmen of the Lighting and the Highways Committees of Leamington have presented the report of their visits to lighting stations. They intended to proceed to Taunton, but, owing to the removal of the works there, had to leave this. They visited the Whitehall installation, Rathbone-place station, and the Chelsea station; interviewed Mr. Joseph Smith, of the Electric Construction Corporation, Mr. J. E. H. Gordon, and Mr. Frank King, superintendent engineer of the Electric Construction Corporation. The report concludes by recommending that the Leamington Corporation, looking at the great development taking place in electric lighting, should themselves apply for a provisional order to enable them either to carry out works of their own, or to license a company with whom they would be able to arrange suitable and mutually advantageous terms. After a long discussion the report was adopted by twelve votes to five. In reply to Councillor Davies, the Mayor said that no steps would be taken to get a provisional order without further resolutions from the Council. The clerk would in the meantime get together the necessary information.

Brighton.—Tenders are being invited from the Brighton Corporation for the execution of the electric lighting scheme proposed by Mr. Shoolbred. The tenders are required separately, or from a single firm with each item separated, for the following: An engine, boiler-house and shaft, two Lancashire and one tubular boilers with water heaters, four sets of "steam dynamos," storage batteries, electrical instruments and apparatus, the supplying and fixing of the cables and protections, the supplying and fixing of the street and junction boxes, connections, and other distributing apparatus. The drawings and specification may be seen, and forms of tender obtained, at the office of Mr. James N. Shoolbred, C.E., of Westminster-chambers, 1, Victoria-street, S.W.; or at the office of Mr. Francis J. Tillstone, town clerk, at the Town Hall, Brighton. Persons desiring to tender will be supplied with a copy of the specification on payment of £5. 5s., which will be returned on the receipt of a tender with the specification attached, provided the Corporation's electrical engineer shall consider such tender to be a bona fide one. Sealed tenders must be left at the town clerk's office at the Town Hall, Brighton, before eleven o'clock in the forenoon on Wednesday, the 9th day of April, 1890.

Mansion Lighting in Ireland.—One of the most successful installations of the electric light for private purposes in Ireland is that just completed at Grove House, in the county Tipperary, the residence of Mr. R. Burke, master of the Tipperary fox hounds. Not only is the entire dwelling-house brilliantly lighted in every part by some 80 or 90 incandescent lamps, but the out offices, and especially the stables and kennels, have had particular care bestowed upon them and are conveniently provided with lamps and switches, so that the electric light can be readily turned on or off in all parts. The importance of the electric light for lighting stables here is at once apparent when it is remembered that the danger attending the use of oil or candles in the case under notice, affect some 25 of the finest hunters to be found in the sister country. The lamps have been very carefully installed, and the advantages attending the new illuminant are warmly appreciated. The installation has been carried out to the specification and under the immediate superintendence of Messrs. J. K. Fahie and Son, the well-known firm of electrical engineers of Dublin. The plants consists of a dynamo of the Elwell-Parker type, driven by a vertical steam-engine, with a storage battery also provided to render the light available when the dynamo is not running.

The Schanschieff Battery.—It is reported by the *Melbourne Argus* that the Victorian Schanschieff Electric Light and Power Company, Limited, has gone into liquidation. The Schanschieff ought to be a standing warning to investors and promoters dealing in primary batteries. We did our best at the time, and in part succeeded, in stopping the immense expenditure of public capital on this scheme, which in its way was a fairly good battery, and in the hands of a small working firm might have had its day and paid. The time was when all Australia was convulsed with the merits of the Schanschieff, and for a time, when Madame Midas took up the scheme for mines, it was the topic of every antipodal breakfast-table. It has gone the way of the others. Battery after battery has opened fire, puffed its puny day, and gone down with the rest. The fingers of several men would not be enough to count off these failures. If a primary battery company wants money from the public, it must show a reasonable amount of actual business and a commercial possibility before it will receive the slightest support even for the formation of a small, very small, company from the technical press. That primary batteries have their field is not disputed, but the failure of the Schanschieff after its brilliant anticipations should be a permanent warning.

Weybridge.—The central station for the lighting of the streets of Weybridge was started on Monday evening last. The installation is interesting to electrical engineers from more than one point of view, and its progress will be watched with attention. In the first place, it is the first installation of the Thomson-Houston series incandescent system in England, and it has also the peculiarity (for England) of being run throughout with overhead wires. The town of Weybridge is very scattered: indeed, there is hardly any town proper, and the whole of the lighting is practically therefore country roads, and on the score of economy, therefore, the overhead system seemed advisable. The installation has been carried out by Messrs. Laing, Wharton, and Down. The dynamos are alternating-current series machines driven by an engine of 80 h.p. About 100 lamps are employed each of 20 c.p., run in series with the paper-film cutout of the Thomson-Houston system. The lines comprise about six miles of roads. The lamps are mounted upon posts fitted with projecting arms, each furnished with a curved opal reflector, at the apex of which is placed the lamp, so that the light is cast well forward and down. The trial runs seem to have been very successful. We have as yet had no opportunity of judging of the effect, but there is no doubt that overhead wires are very much objected to in English towns, and the installation has aroused a great deal of feeling in some quarters amongst the inhabitants on the score of artistic effect against the overhead lines.

Paterson and Cooper's Catalogue.—The new illustrated catalogue of Messrs. Paterson and Cooper's dynamos and electric lighting apparatus has been issued. It contains full particulars of this firm's well-known "Phœnix" dynamo for arc and incandescent lighting. Messrs. Paterson and Cooper have also had a great deal of experience with copper refining and depositing dynamos, and machines for bleaching and other processes. Steamship lighting, again, is a department in which they have been remarkably busy, and the plants for shipwork are numerously illustrated and described, with Phœnix dynamos and combined engines. The Gwynne-Cooper combination of directly-coupled engine and dynamo, the joint patent of Mr. John Gwynne, of Hammersmith, and Mr. Cooper, is shown for sizes for 50 to 200 lamps for ship lighting, an exceedingly compact and well-arranged set. Particulars are given for central station work of alternate-current machines up to 180,000 watts output, with corresponding transformers. Electric motors from ·8 to 40 h.p. on the brake are also fully dealt with. Engines for driving, switches and other apparatus, and the "Phœnix" differential arc lamp, both for ordinary and projector lighting, are described and illustrated. Messrs. Paterson and Cooper have carried out 500 installations during the past six years, and their machines, under the skill and superintendence of their well-known engineer, Mr. W. B. Esson, have achieved very high reputation for efficiency and excellence of design and detail.

Battery Lighting.—Electric lighting by means of batteries is an ever fascinating subject for inventors, and the pet scheme is to be able to sell the waste products, and so have the light for next to nothing. There is another of these schemes, this time hailing from France, which has the claim of a certain amount of originality. This is a single-fluid battery introduced by M. Pollak. It has no porous pot, and contains a plate of zinc as negative electrode, and a plate of lead as positive, with a solution of sulphate of copper as exciting liquid. The zinc is dissolved and the copper is deposited on the lead, the latter remaining inactive. The electrodes of the standard types are made to last for a fortnight, but the maker takes them back in exchange for new ones, the copper paying for the zinc, so that the sulphate of copper is the only expense. Every day a few crystals of sulphate are placed in a trough above the battery, and the water is regulated so that the overflow runs into an automatic circuit-breaker. A suitable number of accumulators are connected with this circuit-breaker separately. This apparatus is composed of a movable receptacle, turning on an horizontal axis, which turns over when full of water. A system of movable contacts puts the battery successively into communication with one of the accumulators at each movement of the circuit-breaker. The lamps are supplied directly from the accumulators, which the battery is constantly charging. A Pollak battery of seven elements and eight small accumulators corresponds to 15 lamp-hours of 8 c.p., and the cost of maintenance is given as about 0·2d. per candle-hour.

Naval Construction.—To obviate the slackness of work in the dead season, the Government Naval authorities have introduced at the dockyard factory at Portsmouth considerable extensions in the manufacturing plant. Among the most interesting machines turned out, the most important are some singularly beautiful and novel engines which have been designed and constructed in the yard for driving the dynamos for producing the electric light. These are the first made, and are of an entirely new character. Two will be supplied to the "Rupert" and three for use in the yard. Instead of being boxed up, and consequently inaccessible, they are entirely open. They are of the compound tandem type, the high-pressure cylinder being placed on the top of the low-pressure cylinder. They are to be driven with steam at 100lb. pressure, and with 380 revolutions, which is considerably under the usual number, they are expected to indicate 65 horses, which is estimated to be equal to 400 amperes and 80 volts. The bearing surfaces are made large in order to remove all risks of heating, and to prevent all danger of fracture the exhaust pipe from the high to the low pressure cylinder is fitted with a gland which admits of a reasonable amount of expansion. Racing, caused by a number of lights being simultaneously switched out of gear, is prevented by spirally-fitted governors, by the sensitive action of which the revolutions cannot by any possibility leap up more than 10, after which they almost instantaneously revert to the normal. Perfect lubrication, both as regards the steam in the cylinders and the moving parts of the engines, is effected by means of a common tank and a number of separate copper pipes, without the use of the usual oilcan.

Electro-Harmonic Society.—An interesting programme has been arranged for the next smoking concert of the Electro-Harmonic Society, which is to take place at the St. James's Hall Restaurant (Banquet Room), Regent-street, W., on Friday next, March 28th, 1890, to commence at eight o'clock. The following are the artistes: Mr. Robert Hilton, Mr. Arthur Thompson, Mr. Edward Dalzell; humorous selections by Mr. John Proctor; violins, Messrs. Jacques Greebe and T. E. Gatehouse; violoncello, Mr. H. Trust; pianoforte, Mr. Alfred Izard; musical directors, Mr. T. E. Gatehouse and Mr. Arthur Thompson; a Broadwood piano will be used. Programme.—Part I: Marche célèbre (F. Lachner) (from orchestral suite), Messrs. Gatehouse, Greebe, Trust, and Izard; song, "I attempt from Love's sickness to fly" (Purcell), Mr. Arthur Thompson; violin duet (unaccompanied), "Scherzo and Rondo" (Mayseder) (from duo in E major), Messrs. Gatehouse and Greebe; song, "Si tra i Ceppi" (Handel), Mr. Robert Hilton; humorous sketch, Mr. John Proctor; violoncello solo, Mr. H. Trust; song, "The Sailor's Grave" (Sullivan), Mr. Edward Dalzell; instrumental trio, "Andante and Gipsy Rondo" (Haydn) (from trio in G major, for violin, 'cello, and piano), Messrs. Gatehouse, Trust, and Izard. Part II: duet, "Love and War" (Cooke), Messrs. E. Dalzell and R. Hilton; violin solo, "Saltarelle" (Alard), Mr. T. E. Gatehouse; song, "To the Nightingale" (Gounod), Mr. Arthur Thompson; humorous sketch, Mr. John Proctor; song, "Now Phœbus sinketh in the West" (Arne), Mr. Robert Hilton; piano solo, Mr. Alfred Izard; new song, "My heart's desire" (Sidney Scott), Mr. E. Dalzell; violin duet, "4th Symphonie Concertante" (C. Dancla), Messrs. Gatehouse and Greebe. Piano, Mr. Alfred Izard.

The Metropolitan.—The Stock Exchange quotations for the Metropolitan Electric Supply Company seem to be very peculiar in the light of a very pertinent article from the *Stock Exchange* newspaper, which says in reference to the year's working, as set forth in the printed report: "To our mind this report designedly mixes up various items so as to hide the actual trading profit or loss; for it must be borne in mind that the Whitehall business, for which £79,988 was to be paid, was bought as a going concern. But the whole gross income from the supply of light and power and other income was only £6,127. 5s. 2d., £15,961. 3s. 5d. being apparently the cost of getting it, which does not include £11,479. 6s. 6d. expended in other ways. The company has been in existence long enough to have done something more than this, especially with such an array of talent as is to be found on the board of directors. The expenditure is clear enough, but the result is very small. From the circumstances attending the formation of the company, we are decidedly of opinion that the object of the creation of the present company was twofold: first, as the public had not very largely supported the South Metropolitan and the Whitehall, a fresh deal on an extended scale was necessary in order to induce them to take a hand, and the attempt, no doubt, succeeded to a certain extent; and, secondly, it was thought that there was a wide field open in the way of obtaining licenses and selling the same to subsidiary or local companies, in the same manner as Brush did with his patents, but, unfortunately, the regulation of the Board of Trade put an end to this part of the scheme. Electric lighting may be made to pay in this country. We do not deny that it has done so yet; but certainly it has not where the company is loaded with dead capital, as in the case before us."

Overhead Wires at Glasgow.—The minutes of the Special Committee on Overhead Electric Light Cables and Wires of the Glasgow Municipal Council contained a report by Mr. David Cook, electrician. Mr. Cook summarised the question thus: "(1) When the alterations specified by Major Cardew have been carried out (which the inspector himself will presumably see to), the overhead wires in this city will not be dangerous under ordinary conditions. (2) But as overhead high-pressure electric light wires, no matter how erected, may become dangerous—particularly to firemen—by contingencies that are not at all improbable, the further extension of the system should be discouraged, and facilities granted for placing all conductors underground. Powers for dealing with this will probably be contained, as is usually the case, in the provisional order and private Act, which the Corporation will have in their hands in the course of this year. (3) As a consequence of the action already taken by the Police Board, control of these wires has practically been assumed by the Board of Trade, in whom is vested all executive control with regard to them. It therefore seems a natural assumption that no responsibility can now attach to the local authority in case of accident, but this is a point upon which I am not competent to offer an opinion." The committee, having considered the report, agreed to recommend that a copy thereof be forwarded to the Board of Trade, and their attention directed thereto. On the motion of Bailie Gray, the minutes were adopted. The minutes of the same committee contained a report by Mr. Cook on the recent fire and accident to a fireman at Messrs. Sorley's. Mr. Cook reported that the fire and accident to the fireman were both due to leakage of the high-potential electricity used for lighting Messrs. Sorley's shop, and the leakage was caused by the men on the job not doing their work properly at a place where it was exceedingly difficult of detection. Moreover, the faulty conductors were arranged in contravention of rules issued by the Institution of Electrical Engineers and insurance companies for the prevention of fires. With these exceptions all the work was well executed, the overhead arrangements conforming fully with the Board of Trade regulations.

Morgan's Police Signal System.—A press view was held at the Westminster Palace Hotel, on Tuesday, of Morgan's automatic electric signal system for police protection. This, though not within the domains of electrical engineering, has a considerable amount of interest for those who occupy themselves with the development of the uses of electricity, and is evidently destined to become a most valuable adjunct to the police of populous centres. The principle involved is not entirely new, for systems of electric communication with police officers at points distant from the centre has had a considerable amount of extension in some towns of America, and a system has already been tried at Islington by the police authorities. The new system has, however, many points of originality, and is an highly ingenious piece of electrical arrangement and clockwork admirably adapted for the purpose in view. A wire is laid to each of a number of specified lamp-posts, each of which is fitted up as a small telephone and telegraph station, and the whole apparatus is made to work automatically in a most ingenious and complete way. The special points are as follows. When a policeman's attention is to be called, a silent and visible signal is thrown up in the form of a red globe around the gas flame. When the officer opens the door with his key, any signal (of which there are 24 distinct messages) can be sent in plain printed Roman characters to and from the central station in case of fire, riot, accident, or other occasion. The central instrument receives these messages from as many as 100 distinct points, by means of clockwork and adjusted slots and cams, which the making of the electric circuit starts by the action of a step-by-step magnet in each transmitter. The apparatus was shown in working with two lamp-posts and worked admirably. In addition to the above indicated use, a small piece of apparatus similar to a watch is also used to enable policemen to repeat their numbers from any of the fixed points to the central. The little case has a spring and clockwork inside, which sends a Morse signal of the man's number when a button is pressed releasing the spring, so that the message is sent without necessity for knowledge of telegraphy. Arrangements were shown of a transmitter which can be placed in every private house on payment of a subscription, by which direct communication with the central police office can be obtained immediately in case of robbery, accident, or fire. The signal system has been worked out by the New Haven Clock Company of New Haven (Connecticut), and Liverpool, who have spent some four or five years in perfecting the apparatus. The patents for Europe are in the hands of Mr. Friedrici, of 76, Finsbury-pavement, acting for Mr. Frank E. Morgan, the president of the New Haven Clock Company. A small syndicate has been formed to exhibit the apparatus in England, and a construction company will doubtless be the outcome of this. The apparatus will be sold or supplied on hire as agreed by the town or county authorities. The apparatus has been seen by the representative of the St. Petersburg police, and M. Goron, of the Paris police, and General Baker Pasha, for the Turkish Government, have also expressed great interest in the system. It will be exhibited to the members of Parliament at the Westminster Palace Hotel, and the interest that has been aroused, together with the completeness and suitability of the system for police purposes, will no doubt ensure its speedy adoption by many of the business centres of the United Kingdom.

HOW TO PRODUCE ELECTRICAL PRESSURE.*

(Continued from page 149.)

The total resistance of any magnetic circuit, just as the total resistance of any conductive circuit, is the sum of the separate resistances. The magnetic resistance of a dynamo generally consists of three parts.

1. The resistance of the core.
2. The resistances of the air spaces between the poles and the armature.
3. The resistance of the armature.

Frequently the core is not a continuous mass of iron, though the resistance would be less if it was, because it is hardly possible to have joints so well made as to give as good conductive continuity as the solid metal. Thus Fig. 18 represents a section of the dynamo, C C represent the part of the core around which the coil is wound. Y represents a yoke joining C C, and should be in good magnetic continuity with C C, as should also the pole-pieces, N S. The lines pass through the air space, through the armature, the other air space, and round the magnet core as shown. The resistance of the whole magnetic circuit then is

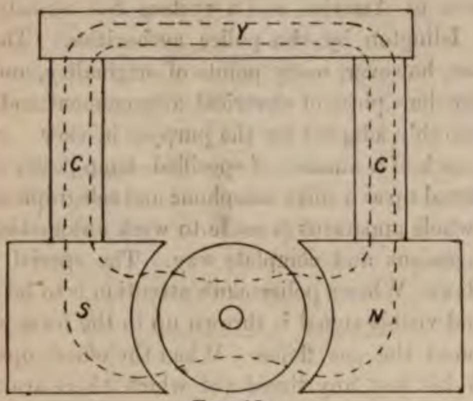

Fig. 18.

$$R = R_1 + R_2 + R_3$$

when R = total resistance; R_1 = resistance of field-magnets; R_2 of air spaces; and R_3 of armature.

The aim of every designer of dynamos should be to make R as small as possible.

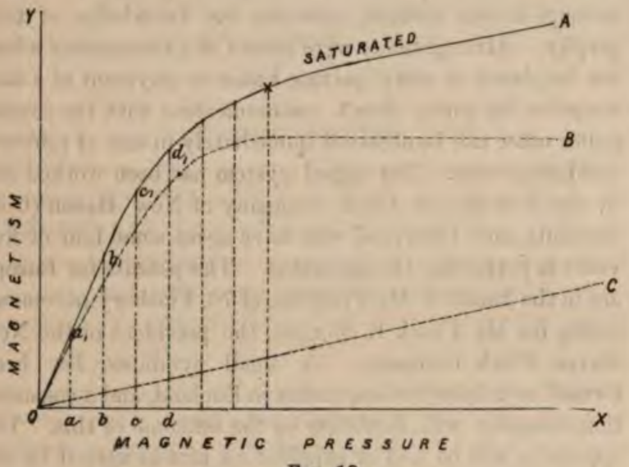

Fig. 19.

The second part of the field-magnet we have to consider is the coil. The lines of force in the core are due to the magnetic pressure from the current in the coil, and primarily to the pressure which sets up the current. It has been calculated that one turn of conductor carrying a current of one ampere will exert a magnetic pressure equal to $\frac{4\pi}{10}$. If the current is any other quantity, and is represented by C in amperes, the pressure is $\frac{4\,\pi\ C}{10}$, and as every turn in the coil exerts its pressure, the total pressure due to T turns is $\frac{4\,\pi\,T\,C}{10}$. Knowing this, we are in a position to write down the formula for the magnetic circuit, thus:

$$\text{No. of lines of force} = \frac{\text{Pressure}}{\text{Resistance}}$$

$$N = \frac{\frac{4\,\pi\,T\,C}{10}}{R_1 + R_2 + R_3} = \frac{2\,\pi\,T\,C}{5(R_1 + R_2 + R_3)}$$

Now, although one ampere-turn always exerts the same pressure, iron—and this is the metal mostly used—does not always have the same resistance. When the current is first applied the lines of force in iron increase practically in direct proportion to the current, but after a certain number of lines pass through the iron the number does not further increase directly in proportion to the current, and it becomes more and more difficult the further we go to force lines through the iron. This result is well shown by the graphic method. In Fig. 19, let O be the origin, O X represent the exciting current, O Y the number of magnetic lines evoked.

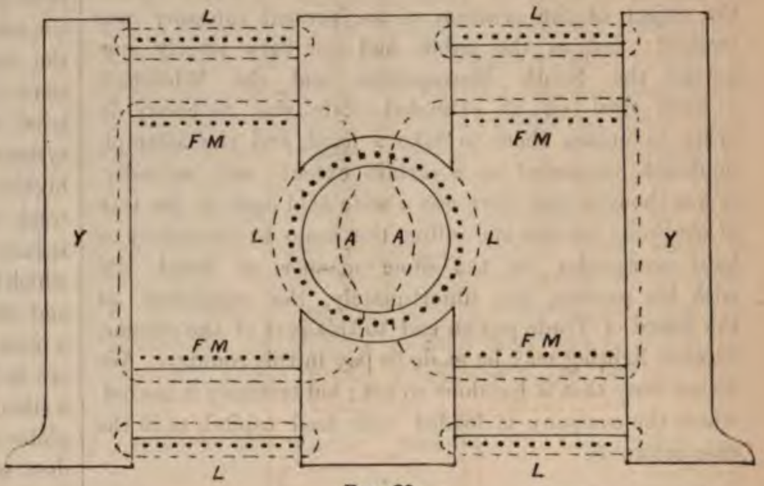

Fig. 20.

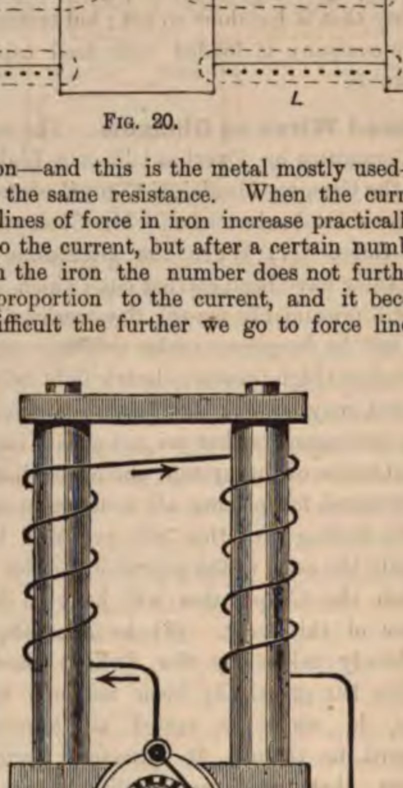

Fig. 21.

The curve O A, which represents the number of lines due to different strengths of current, at first rises almost in a straight line from the origin, then is curved, and subsequently becomes almost straight again. During the third part the iron is said to have become saturated, the curved part shows the effect of the current when it is partially saturated, and the first straight part shows it before saturation.

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* Extracts from "First Principles of Electrical Engineering."

In constructing a dynamo it is necessary to be careful to have sufficient iron in the core so that the iron is not over-saturated. The point where the iron is saturated, or nearly so, should be that aimed to obtain in the finished machine, because the greatest amount of magnetism is there obtained for the smallest expenditure of iron, wire, or current. If a point much below the saturation point is reached a slight increase or decrease of current leads to proportional fluctuations of magnetic lines, while a point higher up the curve—that is, past the point of saturation—needs a large expenditure of current, for which few lines are obtained. It may here be stated that if the coil has no iron in the core—only a circuit of air—the number of lines is proportional to the magnetic force as there is in the dotted line O C. Undoubtedly the air has its saturation point, but that point will be far outside any ordinary pressure.

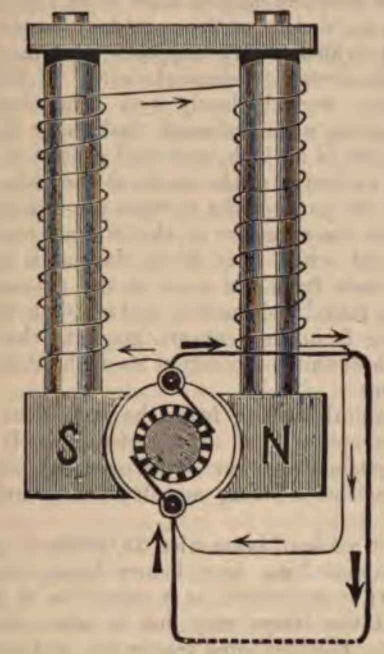

FIG. 22.

Inoperative or Leakage Lines.—If we consider the direction of the lines of force from a coil through an air circuit, the intensity of the lines outside the coil will be sensibly the same in all parts of the external field at equal distances from the exciting wire. The same will hold good for a straight coil and a straight core, because there is no reason why the lines should select one air path more than another, all having the same resistance. Magnetic lines follow the same laws as conductive currents, and divide inversely as the resistances of the circuits. Therefore, although one circuit or branch circuit may be provided which has a much less resistance than any other, only its proportion of magnetic lines will go through this circuit of low resistance. In apparatus such as dynamos it is seen a path of as low resistance as possible is provided, and only the lines going through this circuit are utilised; the remaining lines going through other circuits are wasted, and may therefore be termed leakage lines. In some machines of inferior design leakage is very great, but attention has been paid to this source of loss, and care is now taken in the construction of dynamos to make leakage as small as possible. Thus in Fig. 20 the lines represented by L L L L are all waste, only those encircling the wires in armature, A A, being of service. This fact points further to the necessity of making the magnetic resistance, R, as small as possible. Sharp edges and points about the pole-pieces are found to lead to loss by leakage, hence they are carefully avoided. In Fig. 20 four coils are used, but in a large number of machines, as in Fig. 18, only two coils are used. Waste lines are frequently found going through the base-plate, thus the pole-pieces are usually kept as far away as possible from all accessory iron and from base-plates. The lines of magnetic force depending only upon the ampere-turns, it does not matter whether the lines are generated by coils of few windings and thick wire, of many windings and fine wire, or a combination of the two—all that is necessary is that the sum of the products of the current and the number of turns of wire remains the same. When the core is wound with a few windings of thick wire it is generally for what is termed a *series* machine. In these machines the conductor is wound round the armature, then round the field-magnet, and then to the external circuit, as shown in Fig. 21. In shunt machines, Fig. 22, the field-magnets are generally wound with many turns of finer wire, these turns forming a shunt with the external circuit, the current from the machine dividing itself between the shunt coils and the external circuit inversely as their resistances. Suppose, for example, we require 20,000 ampere-turns, and in the series machine we get them with 1,000 turns and 20 amperes, in the shunt machine we may get them with 5,000 turns and 4 amperes, for 1,000 × 20 = 10,000 × 2. In the third case, or in compound winding, the coils are partly series, and partly shunt wound, Fig. 23. Here we may get the 20,000 ampere-turns by having of the series-turns 300 with 20 amperes, and of the shunt-turns 7,000 with 4 amperes. The total again is :

$$\begin{array}{r}300 \times 20 = 6{,}000\\ 7{,}000 \times 4 = 14{,}000\\ \hline \text{Total, } 20{,}000\end{array}$$

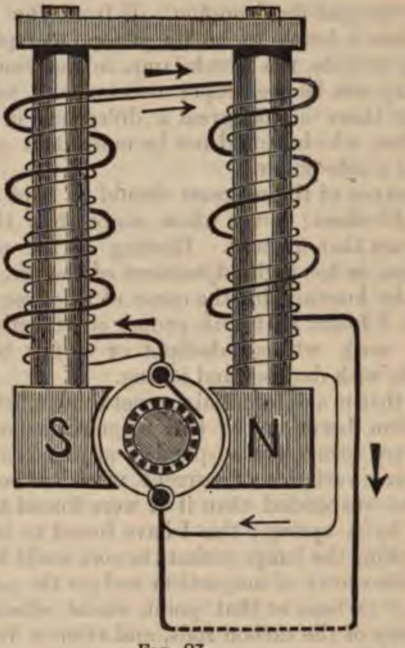

FIG. 23.

(*To be continued.*)

NINE YEARS WITH THE ARC LAMP.*

BY M. D. LAW.

In being honoured with an invitation to read a second paper before the National Electric Light Association, I cannot help but feel that there were points of interest to some of you in my other paper presented at the Niagara Falls Convention. The subject of this paper is one that is of interest not only to every central station man, but also to those who handle arc lights in isolated plants, and if I can give you but one point that is of value I shall feel amply repaid for my labour. There are a large number of irregularities in arc lamps that can be remedied by a judicious study of their actions, and after the cause of their trouble has been found it should be remedied, even if the lamp has to be rebuilt.

In order to find the special trouble that arc lamps are subject to, a careful record should be kept of each and every lamp. To do this, give each lamp its individual number, which should be firmly attached to the lamp-box and never removed, then, by the use of a numbered book, allowing a page for each lamp, a record may be kept of all lamps, where they are, when changed, with the kind and amount of repairs.

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* Paper read before the Convention of the National Electric Light Association at Kansas City.

This method of keeping a lamp record allows of finding the peculiar trouble that the lamp is subject to, and the remedy can then be applied, preventing any further trouble until the washers, clutches, rods, or bushings have to be removed. If a lamp is continually being changed for the same cause, there is some one thing that is radically wrong which is causing the trouble. This should be found and rectified. For instance, a lamp may work perfectly on the test rack, but after being in use for a short time would have to be changed for dropping. If from the records of that lamp this is found to be its general complaint, then look for the trouble, if a Brush lamp, in the winding—that is, there may not be the proper resistance of wire on the magnets, or there is too great a difference in resistance between them, which should not be more than one ohm or the result is a side-puller.

The resistance of the magnets should be kept as near as possible to 85 ohms; never allow more than three ohms variation from that amount. Binding of the mechanism, large washers, or too high adjustment of the arc, will cause dropping; in hunting for the cause of this trouble in the Brush lamp, I found that with proper construction it could be made to work without dashpot or spring, better than the old style with dashpot and spring.

I assume that in a differential magnet there must be a point of equilibrium between the two magnetisms, and that, if the cores were accurately suspended at the centre of this point, that any variation of current would affect the core quicker if so suspended than if it were forced to or from that point by a spring; this I have found to be the fact. Then by making the lamps so that the core could be adjusted to or from the centre of magnetism and get the proper separation of the carbons at that point, would effectually prevent dropping of the carbon rods, and after a Brush lamp is once adjusted in this manner, it will not get out of adjustment until the washers are worn too large. This can be done without glycerine being used in the rods, which is a great source of trouble.

Another point wherein expense is saved in the Brush lamp is in the winding of the cut-out magnet. Divide the magnet in two parts by an extra fibre head, and then by winding the fine wire at the top, with a resistance of 15 ohms, and the coarse wire can then be wound on at the bottom, allowing the end to make connection with the cut-out armature at least one-half an inch from the head of the magnet; this will reduce the chances of burning out. If there is a bad contact when the lamp cuts out, even if it does burn out, only one wire will have to be removed. If the following rules are strictly adhered to in the putting together of a Brush lamp, it will be found to burn correctly with but little adjusting. See that the device carrying the lower carbon holder is parallel with the side rods; also that the screws, etc., at its base work freely, and allow it sufficient lateral motion in all directions to affect the adjustment for which this device is provided. See that the lower carbon holder is in line with its support, or the carbons will not centre. See that the brass tube carrying the upper carbon holder is straight, smooth and free from small or flat places, and that it moves freely in its bushings, which should not be too loose, as this will allow the carbon too much lateral motion and liable to slip past or wedge. See that the upper carbon holder is in line with the rod. This last adjustment is very important, and is made by clamping a steel rod of the same size as the carbons to be used in the holder, and revolving it between the thumb and the finger, noting whether the lower end of the testing rod revolves on its own axis or "wabbles"; in the latter case push the holder up to the lamp-box, and, by means of the testing rod, bend it slightly in the proper direction to correct the error, then see that the carbon holder has not become loosened; test again, repeating the process until the desired adjustment is reached.

Examine the lifting washers which surround the carbon rod, see that the hole is counter sunk on each side, so as to make the available thickness of the washer where it touches the rod but little more than $\frac{1}{16}$th of an inch. See that the hole in the washer is of such a size that one side of the washer may be raised $\frac{1}{16}$th of an inch from the horizontal floor on which it rests before it clamps and commences to lift the rod. See that the holes in the washer and bushings are nicely polished. The lifting finger, designed to lift the washer, should move freely in its guide and get a good hold under the edge of the washer, and allow the latter to rest flat on the floor under it when the finger is down. In the case of double lamps the lifting finger should be so adjusted as to lift the second rod $\frac{1}{16}$th of an inch ahead of the first.

See that the movable brass parts connecting the lifting finger with the movable magnet cores work freely at their joints, so that no binding of the parts may be possible.

The spring which partly supports the magnet cores should be made of steel "pianoforte wire," 27,000ths of an inch in diameter, wound closely over a mandrel of such size that the spring when released shall have an external diameter of $\frac{7}{16}$ths of an inch, and shall consist of about 38 turns of wire, exclusive of the hooks at the ends.

See that all the parts of the dashpot are free and do not bind. See that the armature of the cut-out moves freely on its pivot, and when it is down its end is about one-quarter of an inch from the core of the cut-out magnet, and when it is raised and makes contact with the copper wire projecting from the cut-out magnet, that its end comes about three-thirty-seconds of an inch from the cut-out magnet core.

The brass spiral leading from the cut-out armature is not used as a spring, but as a resistance. It must be pulled out or pushed together as the case may require, that it shall exert neither a lifting nor depressing influence on the armature.

This spiral is made of brass wire 29,000ths of an inch in diameter and about 30in. long before being coiled. The size of this wire is important, as it should be of just right resistance, that the lamps may cut in when the carbons come together. For this same reason the armature is not allowed to come close to the core of the magnet, but should be made to come as close as possible that a better contact may be made, thus reducing the liability of burning out.

The principal improvements that can be made in the Thomson-Houston lamp are the making of the clutch of German silver, or some more durable metal than brass, as the bearing point of the clutch against the rod is so small that it very soon wears, and thus throws the lamp out of adjustment. When one of these lamps is found dropping, it can very often be remedied by lowering the adjusting nut, No. 692, a trifle, when the lamp will again burn correctly, and, in some cases, this may be repeated several times without any other change in the lamp.

Another great point of improvement in this lamp is increasing the thickness of the insulations, which are too small in nearly every case; especially is this the case with those under the binding hooks at the top of the lamp-box, which I find work excellently well when made of porcelain.

When the insulator in part No. 701 gives out, the current shunts through the cut-out magnet, causing what the men term "cut-out armature magnetised." This is a very important point, which produces flaming and dropping.

The general causes of the Thomson-Houston lamps dropping are numerous, but if all the working points move freely and without lost motion, it will reduce the number to the few following points: Badly worn spots in the carbon rods; this is a common fault of all arc lamps. The clutch or lifting springs may have lost their temper; these should be made of bright instead of black steel. Clutch arm bent. Clutch or carbon rod bushings may become worn. The adjustment nut No. 692 may be too high, the clutch or tension spring may be too tight. Crooked frames, bent rods or rods striking the chimney, tight bushings, fine wire broken, dirty rods, or the adjustment nut No. 692 being too low; brush in the bushing may be too tight or become corroded or burned, and the magnetising of the armature before spoken of will cause the lamp to flame and drop.

With the United States or Weston lamp the principal cause of trouble is the tripping from first to second set, and when this happens so that the second set burns first, it generally means a new set of contact springs and new magnet if the lamp burns entirely out of carbons; some of the causes for tripping are—rod sticks or wants new con-

tact brush, lever hook loose, rod scrapes chimney on first set or too much hook on first set, adjusting screw on long hook set too high, lost motion in rocker shaft.

Causes of long arc are—platinum collar dirty or worn out, trip lever sticking or too loose, carbons not burning in proper proportion, burning holder before the carbon rod is down far enough to make contact with trip, small hook dirty, rod crooked near the top, weak magnet, fine wire burnt, clutch holder or armature sticks, rod a little thick at the top and brush too tight.

Causes for dropping out are—weak magnet, either fine or coarse, lost motion in rocker, stiff clutch, too much clutch, not enough clutch, slight nigger in coarse wire, plunger too stiff or too loose, plunger bent, broken or crooked plunger rod, bad carbons, which may on starting become soldered together and cannot lift.

The globe holder or carbon holder of the arc lamp is a very much-neglected part, that is, the insulations are not made heavy enough, but that the carbon dust or copper droppings falling over the insulations will give sufficient leak that a person standing on the ground and touching the bottom of the lamp may receive a very bad shock. This insulation should be made heavy, and so placed that the carbon dust may not fall on it, as it is sometimes impossible to hang lamps under awnings high enough, but that when a person passes under them they may be touched by any conductor which they may have in their hands. No part of the lamp outside of the globe should be allowed to have current in it. Arc lamps should be suspended by some perfect insulator, the regulator porcelain insulator and hook being the best in our experience. This is a very important point and is often neglected. Lamps being hung from an ordinary screw eye by a piece of wire are frequently seen when it is as important that the lamp should be as well insulated as the balance of the circuit. Dirt must not be allowed to accumulate on any part of the lamp; rods, switches, bases, and globes should be kept well cleaned, and all binding screws kept tight; the rods should be kept thoroughly well wiped every day with a clean cloth oı waste. Never allow crocus or emery to be used, as it badly wears the rods in the centre. A better plan is, if the rods become rough or dirty, bring the lamp in and polish on the buffing-wheel, which will allow of its being kept of an even size its entire length. A properly tended lamp will need but little adjusting, but when it is required a regular appointed man should attend to it, or the lamp returned to the station for repairs.

The longest record for any one lamp in a constant street service is three years and nine months without any adjustment other than the ordinary cleaning by the trimmer.

In order to get a good lamp record no lamp should leave the test rack until it is perfect in all parts.

The most vexatious part of the arc lamp is the globe; it swells the item of expense in spite of the utmost care, besides being a great source of complaint, for I never knew one to be well enough cleaned but there would be a complaint that it was not polished. The fused copper dropping and burning on to the glass makes them look dirty in spite of the best cleaning.

I have found, after a careful experiment, that it pays to put wire nets, which should be made of copper on all globes, even for street lighting; having them covered with wire nets prevents pieces from falling out even after they are badly cracked, and if the globe entirely gives way the net will prevent its falling on someone's head. Undue heat after the carbon has burned close to the holder is one of the greatest causes for broken globes. This can be partially overcome by leaving the globe about 1½in. from the carbon holder.

In looking over the reports of former meetings of this convention, it is easy to see that nearly all of the discussions have been on how to save coal. Of course this is a point where large money may be saved by use of proper boilers and settings, but the best of these will do no good without proper firing.

There are many other points in the management of an electric light station which are just as important. The most serious of these is the pay roll, as two men more than is necessary will cost nearly as much as a ton of coal per day, and 30 tons of coal per month would be quite a saving, and yet while keeping the number of men as low as possible, none but first-class men should be employed, that all work may be done in a first-class substantial manner. Especially must trimmers attend to their duty well, as the quality of their work dictates the amount of rebates to be allowed during the month. Another important man in this respect is the dynamo-man. He should give the dynamos the most assiduous attention, that the strength of the current may be kept constant, while flashings and interruptions of the current may be reduced to a minimum, for no matter how well every other department of a station is carried on, if the current is allowed to vary from the standard, complaints will follow, and they are expensive.

There is nothing that angers a user of electric lights so much as to have them flash; it may be only one or two seconds that they are out, but it always seems like a much longer time, especially if in a crowded hall. Rather have the record for continuity of lights so good that even the gas fixtures may be removed; this can only be gained by close attention to the machines, wires, and lamps.

I call to mind one place that we have lighted continuously, without any other method of illumination than arc lamps, for over eight years, and during that time the lights have never been out during lighting hours.

The waste in the use of carbons is a very important feature. These should be dealt out and every stump returned; the amount saved in laying by the 4in. and 5in. stumps to be used in the summer months will make a saving of at least 10,000 carbons per year for a 1,000-light station. At the time I first started dealing out carbons and bringing in stumps I saved on an average over 30dols. per month, and then only trimming about 400 lamps per day.

A very important feature of arc light stations is the inside wiring and line construction which is very much neglected. All inside wiring should be of best quality of insulation, and run on glass or porcelain throughout their whole length. An arc light wire should never be concealed. The use of soft rubber tubing for passing through floors, ceilings, walls, etc., should never be allowed. The only suitable material for such work is hard rubber tubing.

While I am a great believer in the use of the best quality of insulation for line construction, yet it is not best to depend entirely on such insulation for safety. Put up the best wire there is, and then apply a rigid system of inspection and tests, not by that abomination of tests, the magneto bell. Not only should the tests be made on dead lines, but should be made at least once in two hours on all live wires, and when grounds or bad leaks are discovered they should be immediately cleared, by that means preventing the second ground, which is the element of danger.

I have repeatedly had lines that would test clear at the time of putting on circuits, but two hours after solid grounds have been discovered, located, and found to be wires broken down, hanging over the electric light wires and reaching down to the sidewalk, where they are a source of danger to every passer by, besides every boy that passes must feel of it to see if there is any electricity in it. My orders are to drop all work that is not absolutely necessary to clear grounds.

In Philadelphia we receive great help from the Electrical Bureau of the city by their promptly reporting all wires discovered that are down on us.

All lines should be cut by one man who is especially instructed and detailed for that work, as then you are enabled to pick out a thoroughly reliable man and drill him in the work that he is to do, then by never allowing a circuit to be opened, and teaching all men to never depend on any insulation, but to treat all wires and lamps as if they were charged with an electric light current, danger to employés will be reduced to a minimum

Japan.—Companies for the supply of electric light are being started in a large number of the principal towns of Japan, amongst these being Yokohama, Osako, Kioto, and Kobe

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We may occasionally follow the lead of our American Contemporaries, especially when they point out a serviceable way. They are not backward in asking their friends to do all they can for the welfare of the paper. We ask our friends to remember us. No paper that we know ever refuses Subscribers or Advertisers. Nor do we; in fact, we invite them, believing that they will get full value for their money.

Specimen copies of the paper will be sent on request.

THE NATURAL ORDER OF THINGS.

Those who have contended that the natural method is the best in the long run for healthy progress, must feel their views receive confirmation from the present position of electric lighting. The history of the past ten years has been a fruitful one. Few believed ten years ago that a new industry would be inaugurated and obtain a recognised position in so short a space of time. Many argued that the real scope was restricted, and that only as a luxury would the light be required. A few very rich people would adopt it, installations would be made in certain mills and under certain conditions where the matching of coloured goods was an important part of the process in the mill. At first ship lighting hung fire, then it was recognised that for this purpose the electric light was far and away to be preferred over and above all other lights, and through a long period of depression ship lighting kept works going, and prepared the way for further extension on land. Gradually, but surely, the light gained friends, confidence was obtained, for though here and there a failure was recorded, in many more places it was solely depended upon from day to day, with no reserve in case of accident. Day after day it was found satisfactory, and it dawned upon the slow mind of the public that breakdowns ought not to be, and would not be if the workmanship was done well. This gave another fillip to progress, and the promise of current from central stations, with house-to-house canvass, soon proved that the friends of the light were more numerous than its enemies. Gas shareholders and managers have condescended to give it a good word, and have even suggested that it would be wise on the part of gas managers to prepare to supply the rival illuminant. As we have often said, the present confidence in the merits of the electric light is due to the steady work of a few firms. Mistakes have been made by all; errors have been committed, mostly through ignorance, but great care has been exercised to obviate such errors and mistakes as soon as understood. The increase of knowledge has been so rapid that the man who has not changed his opinions with the enlarged views obtainable on the subject is not worth his salt. Consistency is a good thing; persistence in promulgating the orthodox opinion of ten years ago is little short of a crime. Those opinions are altogether out of date, though we may surmise that in several directions we are settling down to a more constant state of affairs. One great problem looms before us, about which opinions are still as diverse as are the winds through the streets of a large city, the problem of distribution. Each partisan thinks his case is proved, and is ready to anathematise all who do not agree with him. The solution of the question is perhaps impossible at the present moment, but time and experience are great aids in solving all problems, and the time during which experience has been gained is as yet very short.

It is a pleasure to note that a broader view is being taken as to question of cost. Direct comparison between one illuminant and another is often difficult, and especially so is it in the case of gas v. electric light. The latter can be used where the former cannot, and in the natural course will be installed in such places. One example is sufficient. Owing to the properties of the electric light, it is now possible to open the British Museum at times when it previously had to be closed.

Naturally, then, electric light would first be adopted in places where no other illuminant could be used; also for certain business purposes wherein the light possesses certain properties necessary for the due performance of the work, and in the houses of the luxurious, who can afford to spend money to obtain better and purer light. From the standpoint of the welfare of the industry these installations prove the certainty and utility of the light, and gradually the desire to possess it percolates downwards. It is found that with it more and better work is done in factories—hence factories are adopting it in greater numbers. It is found that the indirect advantage in private houses and places of business more than balance the increased cost, where that cost is directly compared with the cost of other illuminants, though in many instances the direct cost has been found favourable to the electric light.

A great work of education is being done by local newspapers in giving proper descriptions of installations, and even in incidentally mentioning the advantages obtainable by the use of electricity. One example will suffice. Last week, at Reading, at the invitation of Messrs. Sutton, the members of the Free Library Committee and other friends inspected the incandescent lighting in Messrs. Sutton's premises, carried out by Messrs. Laing, Wharton, and Down. We believe the intention is to introduce the light into the Free Library. The report of the inspection states that "not only was admiration expressed of the quality of the light and its perfect steadiness, but surprise and satisfaction was felt at the very marked difference in the temperature, as much as 15 degrees less heat being registered in rooms where the electric light was installed. This lower temperature was accompanied by much greater purity of the air itself when the gas was not burning." Those who have heard Mr. W. H. Preece address popular audiences on the subject of electric lighting will know how persistently he has always hammered away at these facts, and we fancy the work done at Reading may possibly be due to the germs he has sown, when in that town, as principal speaker at the distribution of the prizes and certificates in connection with the Science and Art Department. Mr. Yeatman, the manager of Messrs. Laing, Wharton, and Down at Reading, must be congratulated upon the success achieved in cultivating the inhabitants in the use of the electric light. When we look at what is being done outside London, at Bradford, Newcastle, Liverpool, Taunton, Bath, and half a score of other places, we are fain to believe that the workers are working in the right direction, and that the natural development is far preferable to the artificial incitement to the investment of money by bubble company promoters. Speaking of Bradford, we are informed that the railway company is installing the electric light at the station, and so the development is continued. From all parts enquiries are made. Town after town is ready to receive full information and a certain proportion to at once commence the work.

AGRICULTURAL HALL.

The first of a series of exhibitions of apparatus incidental to engineers, electricians, builders, and ironmongers has been opened at the Agricultural Hall, Islington, and seems destined to be a very fair success. It remains open till March 29th. The electrical items are not very numerous. Among the novelties is Kent's new arc lamp, with which the exhibition is lighted. This lamp is extremely simple in its mechanism, and, on account of the lowness of the cost due to this, has had already a great demand. We are informed that 1,000 lamps have been sold during the last three months. The lamp has the minimum of working parts, and its action is regulated by means of a strap break worked with a solenoid. It is focus keeping, and in the ordinary size works with any current from 8 to 22 amperes, the adjustment being made by a spring. Lamps are made to run three on a 100-volt circuit. A large lamp of 4,000 c.p. is shown over the bandstand. Another novelty which is doubtless well worth the attention of electrical engineers is glass-lined iron piping for use in electric wiring made by Dan Rylands, of 62, King William-street, E.C., and Barnsley. The ordinary iron pipe is coated inside with cement, and glass tubing is blown on inside, making a perfectly smooth and insulating piping. Joints, tees, and bends are made equally with straight lengths, and the cost is 20 per cent. cheaper than lead piping when fixed. We understand that it is being tested by a prominent company of electrical engineers. Another novelty exhibited for the first time is a floor-board lifter, which should prove most useful to installers. An arched piece with legs to stand each side of the floor-board is fitted above with a powerful screw. On the end of the piece hanging from this is a balanced cross-piece of steel, which can be slipped through an inch hole bored through the floor. This, when slipped through, falls crosswise, and the screw above this simple apparatus being turned, the board is forced up, nails and all, and can be neatly sawn through. When finished the same board can be fitted down again and the hole plugged up. At the Freemasons' Hall it was recently used for 13 carpenters, and saved an immense amount of time. An 1¼ floor-board, fixed with iron sprigs, was raised in 10 minutes. It is made by the Chiswick Floor-Lifter Company, 12, Clements-lane. Messrs. Pyke and Barnett show their new spark coils. These are made to work from either a transformer circuit or from an ordinary battery with Barnett's contact-breaker, condenser, and transformer, and coils are shown producing 30,000 to 100,000 volts. A speciality in manufacture is that the wires are submerged in paraffin oil, so that an accidental sparking through is immediately made up again. They can be used for testing, and one use they are employed for is li up conservatories, etc , with delicately-tinted vacuum tubes of artistic design, and they are also greatly employed for advertising purposes in railway stations and shop windows. The Weymersch Battery Syndicate have an installation of their battery employed for lighting, driving motors, and other purposes. The Acme Electric Works have their switches, cut-outs, and other apparatus on view. An installation of Crossley's gas-engine, 14 h.p. nominal, drives a Thomson-Houston dynamo, with a brilliant display of 30 arc lamps. Messrs. Dick Kerr have also their "Griffin" gas-engine, with double impulse each stroke, driving Excelsior dynamo for the lighting of the exhibition; and Messrs. Ernest Scott and Co.'s "Tyne" dynamo is also shown with these gas-engines. The British Gas Engine Company also show the Atkinson "Cycle" gas-engine for electric lighting. A Statter dynamo by the Electrical Engineering Corporation supplies some arc lamps. Messrs. J. E. H. Andrews and Co. have "Stockport" gas-engines, driving Paterson and Cooper's dynamos. The Fawcett gas-engine, by Fawcett, Preston, and Co., of Liverpool, is shown. This has a regulation of the charge by means of a tapered notched catch for the charge admitter, and has also a new form of valve for admission of explosive charge to the cylinder. It is used for electric lighting in Liverpool. The Campbell gas-engine is also exhibited. The "Newall" high-speed steam-engine has an interesting stand. This engine, it will be remembered, has a valve in the piston head, admitting and cutting off the steam at the piston itself. A miniature machine standing on a table yields $\frac{1}{2}$ h.p., and other larger machines are shown by the makers, Messrs. J. F. Blyth and Co., 108, Fenchurch-street. An interesting stand of elaborate and ornamental fittings, of continental design, for electric light is made by Messrs. O. Berend and Co., 61, Fore-street, E.C., under the name of Saxonian bronze ware.

MUNICIPAL CORPORATIONS AND THE BOARD OF TRADE.

A very important matter has been raised with reference to the power of municipal corporations to delegate their rights on the electric lighting provisional orders, which members of the electrical industry will do well to give careful attention to. At the annual meeting of the Association of Municipal Corporations, held last week at the Guildhall, the Town Clerk of Hull moved: "That, inasmuch as the Board of Trade had intimated their intention not to insert in the electric lighting provisional orders provisions giving local authorities power to transfer their undertakings or to delegate their powers to companies, the secretary be asked to request the Board of Trade to receive a deputation on the subject."

The Town Clerk of Manchester seconded the motion.

The Mayor of Birmingham opposed it, on the ground that if a corporation took up an electric lighting scheme it ought to go on with it. It ought not to abandon it to a company.

The Town Clerk of Blackburn said the Board of Trade last session did sanction such a power in the order they granted to Swansea, and though he should be very sorry to see his corporation evading its responsibilities, he believed that such a power in the hands of a corporation would be valuable. The matter was of very grave importance to those corporations that were promoting provisional orders, and he hoped the association would pass the resolution which the Town Clerk of Hull had put before them.

The resolution was agreed to.

In accordance with this resolution, the Town Clerk of Hull and Mr. A. Goring Pritchard, the secretary, visited the Board of Trade to arrange for a deputation to the President on the subject of inserting powers in electric lighting provisional orders enabling local authorities to transfer their undertakings or delegate their powers to companies. They discussed the question with Mr. Calcraft, the secretary of the Board, and he agreed to amend the model order so as to enable local authorities to delegate their powers to companies, but at the same time he declined to divest the local authority of all responsibility. The model order will accordingly be revised, and Mr. Calcraft has promised, if it be thought advisable, to arrange for a deputation to see the President on the subject.

PRACTICAL HINTS ON COBALT PLATING.

BY ALEXANDER WATT.

Since cobalt as a coating for other metals, as brass, copper, and steel, for instance, presents some advantages which would render cobalting a useful substitute for nickel plating, I have lately made a series of experimental trials with a view to point out as far as possible the most favourable conditions under which successful and uniform results may be obtained in the deposition of this metal for practical purposes. Cobalt, being a whiter metal than nickel, would be a useful coating for ornamental brasswork, as also for small fancy articles in which a cheap white metallic film is desirable. Being softer than nickel, articles coated with cobalt may readily be brightened by burnishing, a process that could not advantageously be applied to nickel-plated surfaces. Like nickel, cobalt is a non-oxidisable metal, and therefore retains its colour in ordinary atmospheres. Although cobalt is a dearer metal than nickel, I am disposed to think that its employment as a substitute for the latter metal would not in the long run greatly exceed, if at all, that of nickel-plating, and for the following reasons: Only one-third of the quantity of "salts" are required to make up a bath; about one-third of the anode surface is required; the deposited metal, being softer than nickel, naturally requires less labour in finishing; and, finally, less current is required than for nickel. Taking, therefore, these points into consideration, they will probably be found to balance those in favour of the cheaper metal. As to the difference in value of the respective metals when actually deposited upon the work done, this might probably be counterbalanced by extra charges for the cobalted articles, which might reasonably be demanded so long as the cobalting remained a novelty.

In making up a bath the salts employed were the double sulphates of cobalt and ammonia, this compound being practically the most suitable for commercial purposes; and in order to ascertain the proper density at which the bath should be prepared, solutions of various densities were tried, and the one which appeared to yield the best results was selected. The next point to determine was the density of current which would give a perfectly adherent deposit of good colour, and free from "burning" at the corners of a flat plate or projecting surfaces of an article. After making many modifications in the strength of the solution it was found that a bath of the specific gravity of 1015 (water being 1000) at 60deg. F. gave the best results, and this was obtained by dissolving $4\frac{1}{2}$oz. of the double sulphates of cobalt and ammonia in one gallon of water. This solution worked most favourably with a current of about ·800 ampere, the E.M.F. being about two volts. The electrodes used in the first trials were a well-cleaned brass plate 3in. by 2in. for the cathode, while the anode consisted of a plate of rolled cobalt, supplied by Messrs. Henry Wiggin and Co., of Birmingham, from whom also the cobalt salts were obtained. The next point to determine was the amount of anode surface which was necessary to admit of a prompt deposit, and yet not too quick for an adherent film. With the current named, and about equal electrode surface, it was found necessary, after a few minutes' immersion of the brass cathode, to remove a considerable portion of the anode from the bath, in consequence of the plate becoming blackened or "burnt," as it is termed, at the corners; when the surface of the anode was reduced to about one-third that of the brass plate deposition took place with perfect uniformity, and there was no longer the least tendency to the discoloration referred to. It thus became evident that an important consideration in the electro-deposition of cobalt is the amount of anode surface which is most suitable in a cobalt bath of a given density. In nickel-plating, a sis well known, this is not a matter of so much importance, and it is commonly the practice to employ a very large surface of anodes in the baths, almost regardless of the actual surface presented by the articles suspended in the solution. My object in directing special attention to this difference between the operations of cobalting and nickel-plating is, that I believe that one of the reasons why the electro-deposition of cobalt has not been successful in some hands is that too little attention has been paid to the detail I have pointed out.

To prepare a solution bath for cobalt plating, 4½oz. of the crystals of double sulphate of nickel and ammonium for each gallon of the bath should be dissolved in hot water, and the solution then made up to the required quantity by the necessary addition of cold water. The solution should then have a specific gravity of about 1015 at the temperature of 60deg. F. For the successful deposition of cobalt upon articles formed of brass, copper, steel or iron, the anodes may be of rolled cobalt, in narrow strips, say about 2in. wide and 12in. to 18in. long, according to the size of the depositing-tank. The anodes should be placed about 6in. apart along the sides of the tank, and in the case of large tanks, say, vessels holding 200 or 300 gallons or more, a corresponding series of anodes should be suspended from a conducting rod placed lengthwise, and resting on the ends of the tank, as in nickel-plating, etc. All work to be coated with cobalt should be polished and prepared for the solution precisely in the same way as for nickel-plating, and before they are immersed in the bath the current must be so regulated that the work may become coated with a film of metal, or "struck," as it is termed, within a few seconds after being placed in the bath. There need be no fear of the work stripping—provided it has been properly potashed and scoured—if the articles become coated immediately after immersion, but in this case the current must be at once reduced, otherwise the work is sure to "burn," or become discoloured, at certain parts in a few minutes after. It is far preferable, indeed, necessary, after the first film has been obtained, to immediately diminish the current, this being again augmented when other articles are put into the bath. By watching the rate at which each article becomes coated, and regulating the current accordingly, the probability of burning the work will be readily overcome. My reason for directing special attention to this is that cobalt deposits so much more readily than nickel, that any person unacquainted with the deposition of cobalt and treating it as he would nickel might naturally fall into error, readily avoided, which would cause failure and disappointment. It should always be the rule, therefore, in cobalt plating to diminish the current so soon as the article is fairly coated all over, but more especially is this the case when the work becomes coated instantly after immersion. Since copper does not appear to receive a deposit of cobalt quite so readily as brass with the same amount of current, it will be found advisable, when copper articles are to be cobalted, to start with a somewhat stronger current than would be required for the yellow alloy, but when the piece of work has fairly struck all over with the stronger current, this must afterwards be reduced somewhat during the remainder of the time the article is in the bath. In cases where a dead cobalt surface is required the articles, having been dipped in the usual way, may be scoured with powdered pumice, or, still better, with powdered bathbrick, and after rinsing placed in the bath, using a rather strong current at first, and reducing it after the work is coated all over. If such articles have projecting points these must not be allowed to approach too close to the anodes, otherwise such parts will be apt to become dark; should such be the case at any time, however, the piece of work must be removed and again scoured at the discoloured spot and then rinsed and returned to the bath, a weaker current being used. All dead work, after removal from the bath, should be plunged into clean boiling water and allowed to dry spontaneously, care being taken not to handle the work at such parts as will be required to present a clean white surface. When a brighter surface is required the work may be scratch-brushed at the lathe with brushes made from fine steel wire, moistened with beer in the usual way, after which the pieces may be dipped in a solution of cyanide of potassium, and finally rinsed in boiling water and then put into clean box sawdust. Buttons and other small fancy brass articles may be treated in this way.

In depositing cobalt upon steel or iron surfaces a much weaker current is required than for either brass or copper. The current from a single Daniell cell is amply sufficient for coating small steel articles, and, since cobalt adheres very firmly to this metal, it will be found useful for imparting a white coating to many articles formed of steel or iron. It is also important to note that steel articles coated with cobalt may be brightened by ordinary burnishing, for, as before observed, cobalt is softer than nickel and yields very readily to the pressure of the burnisher. When depositing cobalt upon cast iron, a rather strong current must be used to secure an immediate coating after the work has been placed in the bath, after which, as before, the strength must be diminished and sustained at a uniform density until a sufficiently stout coating is obtained. Here, again, it is necessary to point out that projecting surfaces must be kept as far away from the anode as possible, so that those portions may not become discoloured or "burnt" and necessitate rescouring.

There is another feature in cobalt depositing which presents an advantage over nickeling which it is well to mention, namely, that when it is found necessary from any cause to rescour a piece of work and return it to the bath until finished, the operator need not fear, I believe, that the work will be liable to strip after the second coat has been given, for I have generally found that brass and even steel surfaces may be frequently rescoured and cobalted again and again without the metal stripping in the least degree. In the case of nickel we all know that the deposition of film upon film of this metal is almost invariably succeeded by the second coating separating from its predecessor. It may be further remarked that the rescouring of the work, to produce an improved surface upon a defective film, can scarcely be applied to a nickel-plated article, owing to the extreme hardness of the metal. With respect to cobalt, however, the case is different, for with good brisk brushing with pumice, silver sand, or bathbrick reduced to a powder, I have found no difficulty in producing the surface necessary for a satisfactory deposit of the metal when from various causes it was found necessary to repeatedly rescour the plates used in the experimental trials referred to. In no instance, however, did the subsequent layers of cobalt strip or peel off the metal already deposited.

Some attempts were made to deposit cobalt upon zinc from the double sulphate solution, but in each instance it was found that the film was non-adherent, except in portions of surface where partial adhesion of the metals occurred. Although there are some other solutions of cobalt than the above which would be more suitable for cobalting zinc, it is somewhat doubtful whether a really good deposit of cobalt on this metal could be obtained with any degree of certainty.

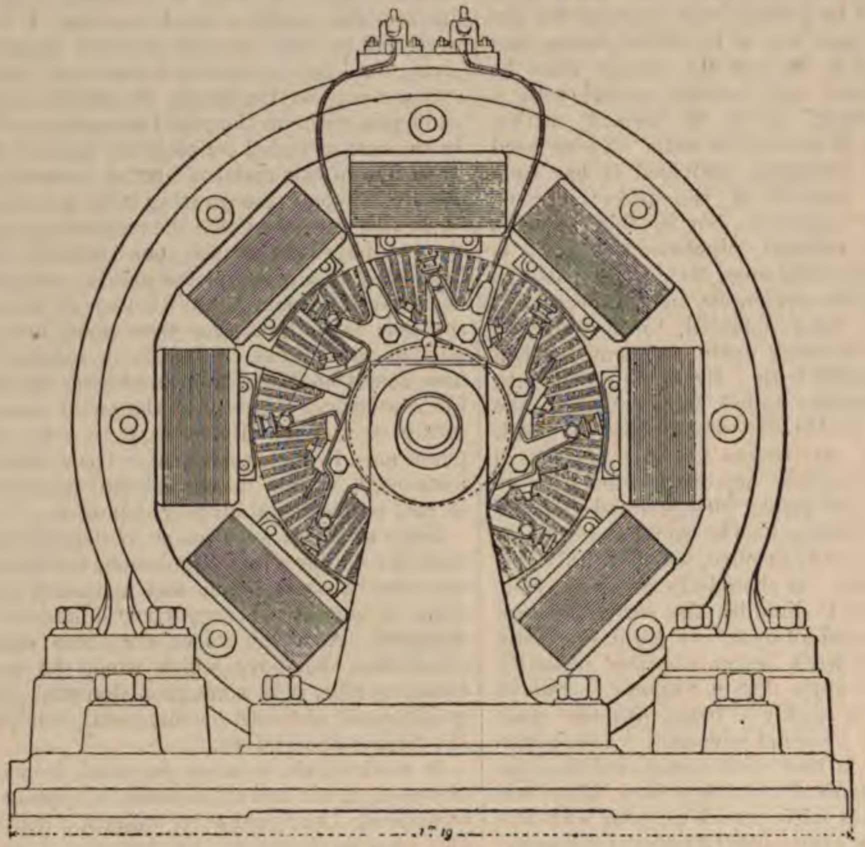
In working the solution prepared from the double sulphates of cobalt and ammonium, it appears to be necessary to maintain the liquid at as uniform a density as possible, and for several reasons. For instance, if the bath be allowed to acquire a higher density than about 1015, by the spontaneous evaporation of a portion of its water, the colour of the deposit will probably become affected, and a darker tone imparted to the articles instead of a tolerably good white characteristic of electrolytic cobalt when deposited under more favourable conditions. To obviate such a defect in the metallic strength of the bath, the hydrometer should be floated in the liquid at least once a week, especially in warm weather; and whenever the solution indicates a higher density than it originally had, an addition of water must be made until the specific gravity has been reduced to the proper figure. These additions of water, however, should be made in the evening, or when the bath is not being used, and the solution must be well stirred, and then allowed to rest for at least 12 hours. It is also necessary to avoid adding an excess of water, since a solution much weaker than that indicated will be apt to cause the deposit to be patchy, and certain parts of the article may for a time refuse to receive the deposit. These observations are based upon results actually obtained under the conditions referred to, but the defects may readily be avoided by adopting the precautions suggested.

Respecting what is understood as the *colour* of the deposit, this is greatly influenced by the strength and tension of the current. For instance, it is perfectly easy to obtain films of cobalt upon brass surfaces with an E.M.F. of one volt and a large surface of anode, but this deposit will not be so white as when the current has an E.M.F. of two volts, with small anode surface—that is, about two-thirds less than that of the cathode, or article to be coated.

With respect to the purposes to which cobalting is most applicable, these may be taken as being, on the whole, as similar to those for which nickel-plating is adopted, but, like the latter metal, it should never be applied to culinary or drinking vessels, since it is, like nickel, readily acted upon and stained by vegetable acids, as vinegar, for example, beer, and also by vegetable infusions, such as tea, the water in which cabbages have been boiled, and other liquors of a similar nature. Cobalt also resembles nickel in becoming dull when long exposed to damp atmospheres, and should not, therefore, be employed for articles which are required for out-of-door ornamentation, unless the surfaces can be persistently rubbed over with a dry leather every day. On the other hand, cobalt plating may be adopted for any class of art-metal work which is destined to remain in ordinary dry apartments, as fenders, fireirons, etc., or for ornamental work to be worn on the person. Mullers, sausage warmers, dental instruments, and cast brasswork, such as lavatory taps and so forth, may be advantageously coated with cobalt, the articles being prepared and finished as before observed precisely in the same way as in nickel-plating.

THE RECHNIEWSKI DYNAMO.

Are the field-magnets laminated? is by no means an infrequent question when talking about dynamos. M. Rechniewski believes in a thorough lamination of his pole-pieces, and so would a good many constructors if they could overcome the prejudice against increased cost of construction. A machine, and especially a dynamo, is and must be a compromise between theory and practical construction. A more perfect machine may be designed, but it will not pay to produce it, and to such a perfection is the "efficiency" of the machine carried by the best constructors, that the question of "more in accord with theory" is met with the reply, it won't pay. There is little to be said of the Rechniewksi machine, except that he uses laminated field-magnet cores instead of solid cast or wrought-iron cores. The armature is practically a Siemens armature. The Société l'Eclairage Electrique constructs these machines in various standard types, to give from 150 to 120,000 watts. The output per weight is one horse-power for from 55lb. to 65lb., according to the size. The efficiency claimed is from 88 to 95 per cent., and, as we say, the sole question is whether this efficiency is greater than that of non-laminated machines—in fact, so much greater to warrant the extra cost in building, as the sheets have to be insulated and the whole connected. The figure shows a multipolar machine.



The Rechniewski Dynamo.

SAFETY AND SAFETY DEVICES IN ELECTRIC INSTALLATIONS.*

BY PROF. ELIHU THOMSON.

The development of the electrical arts, particularly in the direction of lighting and motive power transmission, has, in the past few years, been very great. It has brought with it a demand for very much work of a novel character, as regards the details of plant and methods of installation. It has also entailed, in many cases, elements of risk to life and danger of fire. How far these risks have been or can be removed by proper attention to details and care in installation, has become an important subject for discussion. How far such risks have been increased by reckless installation of conductors, by faulty materials and supervision, it is not easy to determine. There can be no doubt, however, that electricity, as an agent, in itself is not to be charged with bringing about the results for which recklessness in its use is sufficient to account. That, under favourable conditions for discharge through a person's body, electric currents of comparatively high pressure may injure or kill, is not to be questioned for a moment. I have no sympathy with any effort tending to impress a false estimate of such risks, or tending to give the impression that they are absent when in reality they are existent. I have no sympathy with any effort to exaggerate such risks, efforts which have not been wanting, indeed, as is well known. The fire risk, as well as the personal risk, involved in electric work is present in a greater or less degree, in accordance with

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[*] Paper read before the National Electric Light Convention at Kansas City.

the perfection of the work of installation and maintenance, the provision of the proper safeguards, and selection of the best conditions.

These are matters which are every day of growing importance in all the electric industries, not even excepting telephonic systems and other such work, which, if badly arranged and not properly maintained, may cause crosses due to falling wires, etc., to become sources of danger, trouble, and annoyance in the distribution of lighting or other currents. There is one fact which is of the greatest importance in this connection, and it is that safe installation means, also, good service. There can be no question that the risk to life from shocks, even with bad work, would be removed by not using high-potential currents, as they are called, either alternating or direct. There can be no question, also, that a shock obtained from certain characters of current, such as alternating current, is much less safe than in the case of continuous currents of equivalent pressures. Nevertheless, I am just as firmly convinced that the fire risk is very much less with alternating than with continuous currents of equivalent potential, assuming the work of installation equally good. The fact that it is difficult to sustain an arc, or rather that it is easy to select conditions which will prevent arcs forming with the alternating system, as compared with the continuous-current systems of much less potential, is greatly in favour of the former. Hence switches, fuses, bad joints, ruptured wires, are much less liable to arc and incur risk of fire with alternating than with continuous currents. Would it be possible to work successfully using only low-potential currents of either character? Would we be able to utilise water powers for lighting, without employing pressure of potential sufficient to convey the energy to a distance over a conductor of moderate or non-prohibitive cost? In most cases we would certainly not be so able. Again, to utilise water frontage for cheap coal supply, and to employ compound condensing engines, to ensure small running expenses by massing the machinery at one station, to make use of railroad facilities, etc., in short, to work under the most advantageous operative and economical conditions, we must convey electrical energy by moderately high electric pressures, so as to avoid prohibitive losses or prohibitive cost of conducting wires. If ever our great natural resources in water powers are to be developed and utilised, it will be by the employment of comparatively great electrical pressures for conveyance of energy to distant points. If great saving of cost of fuel and other expenses in operating one large steam plant, instead of a number of separate plants, with their attendant risks, in large cities, is an object worth seeking, it will be found in the conveyance of electric energy at fairly high pressures. It must not be forgotten in this connection that, even with very low-pressure currents, safety from fire risk is only to be secured by careful construction and supervision, and that risk of fire often involves personal risk. Subway and underground conductors have caused manhole explosions with both low and high potential currents. Such accidents are generally explained by accumulations of coal gas formed in the manhole, and subsequently fired by the electric arc or spark of a leak. This may be, and probably is, sufficient explanation, but another may be given—the evidence of the possible correctness of which I have witnessed. A heavy leak or overheating occurring at some point of the conductors near the manhole may generate directly a large volume of inflammable gas from the distillation of asphaltum or other substance used as an insulator; and this gas, mixing with the air of the manhole, may be easily fired by the heat of an arc or spark subsequent to its production, and cause a violent explosion. The remedy is thorough and continuous ventilation of the spaces in the manhole and subway. An instance of a storage battery car being wrecked from a similar cause is on record. In this case the battery conductors were probably overheated by a short circuit and filled the compartment in which the batteries were with inflammable gases, and the further heating fired the mixture, the result being a violent explosion which greatly damaged the car. Such accidents always involve personal risks, and are to be prevented by simple means properly applied,

But the popular mind is so used to gas explosions that the newspapers have only a few lines to devote to them, while an accident in which an electric shock is obtained, although it has taken place through disregard of some simple precaution, is more than likely to be copiously provided with head lines and harrowing details. I even find one of the journals, whose name states its scientific character, attributing both the Lynn and Boston fires to electric wires. There is on exhibition at Lynn, as a curiosity, the oil stove which caused the fire, and enquiry into the cause of the Boston fire has, so far as I can learn, rather tended to discredit the theory than to confirm it. Notwithstanding these facts, it is true that under faulty conditions of lines or plant fires may arise, and hitherto have arisen, traceable directly to the heating effects of electric currents. Perhaps if the accidents which happen serve to enforce the fact that the best work, the most thorough provision for emergencies, and careful consideration of details of electric work will be requisite to secure proper safety in the electrical field as in other classes of work, their mission will be fulfilled. Severe and inconsiderate as has been the dealing with the wire question by the authorities in New York City, yet it cannot be denied that the condition of the overhead circuits there had been in the past few years going from very bad to much worse. In many cases considerations of safe working would seem to have been neglected in the competition for business. The lines of four or five different companies competing in the same territory might be found, the result of this condition being, without doubt, to enormously increase the risks. There have been hints of the coupling-up of dynamos in series, and so increasing the potential of lines already worked at too high pressures in relation to their condition of insulation, and to the placing of the lamps or other work supplied from such lines. Along with this we find the air full of telephone, telegraph, and signal wires of various sorts, none too secure from rusting out or breaking. Many of these latter wires could, no doubt, be easily buried underground with advantage to the service, but it is certain that to attempt to bury the electric light wires in a hasty, ill-considered fashion, merely for the sake of getting rid of overhead lines, would be productive of no good results, either in avoiding risks or bettering the service. The placing underground of very many of the wires now found overhead in our large cities is, in my opinion, a matter which must come in time, but it should be done carefully and gradually, so as to secure the best work. Meanwhile, the reorganisation of existing wires, the removal of unused wires or redundant wires, as where two systems or circuits in the same territory overlap while serving substantially the same purpose of supply, and the use of first-class insulation on the wires would go far to securing safe working and uniformly good service. Besides all these precautions, and outside of them, whenever the conditions are and have been favourable to safe installation of overhead or underground circuits, there are to be found a class of appliances which are called "safety devices," inasmuch as it is their purpose to provide for abnormal conditions and to remove risks which, with perfect working and maintenance, are usually absent, but may be brought into existence by accident or unforeseen defects. Such risks may be by outside interference with lines, or by lightning, by falling or poorly-constructed signal and other wires upon overhead wires, by unusual wind or sleet storms, by failures of all kinds, as in the working of lamps, switches, etc. It is here that the safety device is found to be useful. Such devices are to the electrical systems what check valves, overflows, trap and safety valves, are to hydraulic systems. There is, of course, no room for doubt that if the insulation of all parts of the plant, as dynamos, lines, lamps, etc., were maintained always at its best, and if the mechanical strength of lines, hangers, poles, etc., could be always relied upon, and, further, if the effects of lightning induction were never present, there would be but little use for any purely electrical safety appliances, such as those for guarding against leaks and diversions of current. To expect such perfection of conditions is to expect too much. A rigid system of frequent testing can, however, go far to anticipate and to discover the departures from such safe conditions, and enable the disturbing conditions to be removed

Nevertheless, there will always remain opportunity for unskilled or careless handling, so altering the condition as to provoke trouble; there will always remain chances of undiscovered defects, chances of interference from outside. The effects of lightning are an important factor during the thunderstorm season. I am driven to conclude, therefore, that safety devices are, and will continue to be, important factors in electric work. The more thoroughly they are adapted to their intended functions, the greater the security, and the more extended their application. That system of distribution will surely survive which, while involving economy of first cost and maintenance, at the same time secures the greater safety and embodies the greatest flexibility. I assume, of course, that the running economy is practically good in every case.

In the very early days of arc lighting with a single lamp only on a circuit, the idea of safety from fire or shock did not present itself. When such lamps began to be run in a series of eight or ten, or more, the need of an efficient cut-out was felt, so that a defective lamp failing to feed its carbons should not burn with a long arc or flame, and so involve risk of fire or extinguish the other lights. This need was met in 1876 by Lontin, who used the shunt circuit to actuate a shunting switch around the defective lamp. The Brush cut-out followed, and was a decided improvement on Lontin. Fuller and others early went over the same ground. The film cut-out, or shunting switch, depending on a small thickness of a high-resistance insulator, such as oiled paper, to prevent its closure, which paper film is overcome by the difference of potential or pressure between the carbons when a long arc forms, was brought out by the writer, and later the "vacuum cut-out," a modification which rendered the device self-setting for repeated action if needed. It is scarcely necessary to add that spark-catchers and enclosing globes with wire nettings were early additions to arc lamps to prevent sparks reaching inflammable material near by, and the globe also in addition served to diffuse the light. Current regulators were additions to arc machines, and acted to prevent undue current, and secure thereby not only safety, but good service. The fact that good service in most cases is assisted by appliances which ensure the safety, or is even dependent on them, is a fact which ought not to be lost sight of in connection with the general subject of electric installation. The early installations for arc light in and out of buildings were made with bare wire circuits, and it is a satisfaction to me to recall in these days of forgetfulness of the benefits conferred by electric industries, and exaggeration of the dangers of properly installed plants, a case which occurred in connection with one of the earliest commercial plants of the Thomson-Houston arc lights in 1879. The machine of about eight or nine lights' capacity, with bare wire lines, was put up in a large brewery in Philadelphia; two arc lights lighting the stables in which were thirty, or more, valuable horses. One evening a fire started in the hay-lofts in the storey above, and where there were no lights of any kind used, and soon the flame and smoke spread to the stable-room and menaced the horses. The proprietor happened to think to start up the electric lights at this juncture. Their brilliant rays saved the animals, which were removed without trouble, and the lights were kept burning during the progress of the fire. Its spread was limited by the efficient work of the fire department. The arc lamp globes were at times full of water, but to the surprise of the firemen the lights were not extinguished, but assisted them in their efforts very materially.

As the number of arc lights placed in a circuit grew the necessity for thorough insulation was appreciated, the effort to secure which for arc lighting lines has resulted in very great improvements being made in the past few years. So far as electric wires go, the best "safety device" is a perfect insulation. In order that this matter shall not assume the condition of a trial of strength between armour and armour-piercing, as in naval affairs, with a constant growth of both, the advantage always being on the side of armour-piercing or insulation-piercing, I think that efforts to run more than a certain limited number of arc lights in series should be discouraged. Eighty or 100 lights, or even more, have been run and could doubtless be run safely under favourable conditions, but I doubt that such conditions can be found in city work; the interfering actions are too numerous, while the maintenance of good conditions would be too expensive. Without such good conditions, there would be grave dangers involved.

It has become a practice to use incandescent lamps of low resistance in series on arc light circuits or other constant-current lines and much useful work is so accomplished. Here, again, safety from fire risks depends on certain safety devices, the most important of which is the shunt-forming device, when the carbon lamp conductor breaks. A number of very simple and effective devices are employed for this shunting action. Without such devices the tendency to arcing would be very great. It is advisable also not to rely on any one device alone for this purpose, especially if the lights are used indoors. Here the film cut-outs may supplement the action of a shunting device operated by the heat of an arc set up when the lamp carbon becomes discontinuous. These latter are the fusing cut-outs, twisted wire cut-outs, and others which connect the lamp wires together in the lamp, and so form a complete shunt. Other forms exist, notably the third wire cut-out, acting by diversion of current from the arc to a third or intermediate wire between the lamp conductors.

As in case of the other devices mentioned, the perfection of operation of one, or a combination of several of these shunting contrivances, conduces not only to uniform service but to absence of risk. Absolute cut-off switches are now in common, if not in universal, use to cutout loops of series circuits, and in a measure may therefore be regarded as safety devices, but not of an automatic character. Outside of these factors just mentioned, safety in such circuits rests in insulation and maintenance, avoidance of leaks or crosses, proper placing of wires and lamps, avoidance of partial contacts or partial ruptures of the current at joints, binding-posts, or switches. In series circuits the main object is to avoid a concentration of, or establishment of, large differences of potential at points in the line where the currents find or can find a path. In low potential multiple arc systems, as used in direct incandescent work, the object is to avoid concentration of current at points where such current cannot find a sufficiently low resistance path. Hence there is required cut-offs for current when excessive in any part of the system. Short circuits of accidental character must be provided against. If the safeguards are not ample, a more potent fire producer than a short-circuited section of an extended multiple arc system is hard to find. Take out your fuse wires and replace them with copper wires, a practice instances of which were not difficult to find in times past, and a short circuit may quickly heat a long line of wire in a building so as to set fire to the insulation of the wire and surrounding woodwork. The fusible wire cut-out, if properly made and used, is an effective preventive of such risks, though magnetic cut-offs are preferred by some, though more expensive. The magnetic cut-offs, which are simply open-circuiting switches, controlled by magnets in the branch or line so as to open it on excessive current, have the advantages of promptness, avoidance of the scattering about of fused metal, and can be reset without any renewal of material, so differing from the case of a fuse wire. Another risk in such systems is that of creeping of current from main to main over moist surfaces, or partial conductors, in amount insufficient to blow a fuse, but sufficient to convert enough energy into heat to set a fire. Good waterproof insulation of wires avoids this risk if the insulation remains intact. I consider the plan of running the two branch wires, excepting the larger ones of the system, near together or close together as excellent in avoiding this risk, provided the wires are encased in insulation and covered in, or run in a tube. In case of a leak from main to main, the more quickly the fuses blow, the better; and the proximity of the wires assists this speedy action, while between the wires there is not at any time enough combustible matter to set a fire by the short circuit. Enclosure in a tube effectually shuts off possibility of flame reaching combustible matter before the fuse blows. This does not apply to the heavier mains, capable of carrying thousands of amperes, so well as it does to the smaller branches.

(To be continued).

SOME POINTS IN DYNAMO AND MOTOR DESIGN.*

BY W. B. ESSON, MEMBER.

(Concluded from page 219.)

If the armature of a machine is lengthened the electrical work which can be performed by it is increased in proportion. The magnetising force and the ampere-turns on the armature remain the same, and the forward and cross induction bear to each other the same ratio. Here the electrical work for the same number of revolutions per minute is proportional to the weight of the magnetic system, and rather more than proportional to the total weight. The surface velocity of the armature is of course unchanged. Let all the linear dimensions of the magnetic system be increased n times. The length of each component of the magnetic circuit being n times longer, the magnetising force must be n times greater for the same degree of saturation, the total forward induction having $n^{\frac{3}{2}}$ times its former value. The copper on the armature being n times thicker, the ampere-turns which may be carried to raise it to the same temperature will be $n^{\frac{3}{2}}$, and the output, therefore, at the same number of revolutions per minute, $n^{3\frac{1}{2}}$, the E.M.F. being n^2. If the speed is inversely as the linear dimensions, the output is, obviously, $n^{2\frac{1}{2}}$. Now, in increasing all the linear dimensions—the air gap in proportion—we have increased the tendency to sparking. The lengths of the cross circuits are n times longer; consequently, for n times the ampere-turns on this armature, the ratio of the cross induction to the forward induction would be as formerly. But we have put on it $n^{\frac{3}{2}}$ ampere-turns, and the air gap must therefore be increased in the same proportion, in order that the tendency to sparking may be neutralised. Under these circumstances the magnetising force will be greater than n; but, taking into account the increased air gap, and the increased compensating ampere-turns on the magnets, the weight of copper on these will not be greater than n^3; and this amount we can afford to have on a machine in which the other weights are increased in similar ratio. It appears, then, that with due regard to the balance of the magnet and armature fields, the output is not quite proportional to the weight, if the surface velocity of the armature remains the same, but that for similar machines it increases as the 2½ power of the linear dimensions. Of course, this depends to a great extent upon the original machine. If the armature of this is under-loaded, it may be quite possible in the larger machine to take advantage of the condition that less space is taken by the insulation, and so load it to a greater number of ampere-turns than $n^{\frac{3}{2}}$; but if the balance of fields is to be the same in each, $n^{\frac{3}{2}}$ represents the permissible ration of ampere-turns. It will be found, I think, that where the output increases directly as the weight, the surface velocity of the armature is in the larger machines greater.

With these remarks I bring this somewhat lengthy contribution to a conclusion.

APPENDIX.

The following are copies of the letters referred to in the text respecting the "Wood" and "Sperry" dynamos:

"New York, Dec. 2, 1889.

"W. B. Esson, London, England

"Dear Sir,—In reply to your letter of October 21, requesting data of machines made by this company, I send you the following: Difference of potentials at terminals of machine, 2,640 volts; current, 9·6 amperes; revolutions per minute, 875; sections in commutator, 120; convolutions per section of armature, 72; cross-section of iron in armature ring, 14 square inches. Pole-pieces are bored concentrically with the armature; sparking at the brushes is eliminated by the use of an extra brush connected to collecting brush, with a separation on commutator of from five to ten sections, depending on the lead, or, in other words, a counter E.M.F. to reduce spark. I must apologise to you for the delay in answering your letter, and hope that I may be in time for you to make use of data as intended.—I am, yours truly,

"CHARLES J. BOGUE,

"The New American Electrical Arc Light Company."

"Chicago, June 11, 1889.

"Mr. W. B. Esson, West Hackney, N.E., London.

"Dear Sir,—Yours of October 21st at hand. Am pleased to notice contents, and in reply would say that the matter of regulation by shifting the brushes I have gone into as exhaustively, perhaps, as anyone in this country. I have had unlimited capital at my disposal, and have made an exhaustive series of experiments, and can say from knowledge that it depends for its success almost solely upon what we know as the balance between the armature and field. This might more properly be termed the preponderance of the induction of the field over that of the armature. . . . . . In the machines we build, the brushes can stand in any position from 0 E.M.F. to full E.M.F. without a particle of sparking upon the commutator, the commutator wearing smooth and glazing over with any position of brushes.

"The machine at the Paris Expositionis a 14in. machine—that is, the exterior dimension of the armature is 14in. The actual exterior dimension of the core when ready for winding is 13½in.

"The normal speed of machines of this size is about 1,000 revolutions. The E.M.F. of the armature at the brushes, before going through the fields, is about 620 volts, with 10 amperes in the fields.

"The internal dimension of the core is $10\frac{9}{16}$in., and the length of the core is 6¼in. The insulation in mass of core is 20½ per cent. There are 72 sections in the commutator. There are four layers, with 10 convolutions in each layer, of wire upon the armature. From these dimensions you can get the actual area of iron.

"The field is bored perfectly concentric with the armature, and a good liberal clearance is allowed, usually about $\frac{5}{32}$ of an inch exterior to the bands of the armature, perhaps $\frac{1}{32}$ less in the case of small machines. Yours very truly,

"ELMER A. SPERRY."

JOINT DISCUSSION ON MR. SWINBURNE'S PAPER, "THE THEORY OF ARMATURE REACTION IN DYNAMOS AND MOTORS," AND ON MR. ESSON'S PAPER, "SOME POINTS IN DYNAMO AND MOTOR DESIGN."

(Authorised Abstract.)

Before the commencement of the discussion proper, **Mr. Esson** made a few remarks on the construction of the armature cores in the machines used as dynamos and motors, the results of which are given on slip 19. The Gramme and Pacinotti, he said, were built up of thin discs, whilst the Bürgin had wire cores carried by six-armed spiders. He thought the great difference between the E.M.F. of the latter, when used as dynamo and motor, might be due to the iron wires having been brought into electric contact by forcing the spiders in the rings, and thus causing parasitic currents. He also corrected an error made in stating Mr. Ravenshaw's rule on slip 13, where, instead of the ampere-turns being 24 and 48 times the area of the field-magnets, 35 and 70 times the area of the armature core should be substituted. With reference to this rule, Mr. Esson said, if it was true, then by doubling the length of an armature the load might be doubled without giving rise to sparking. In his opinion, the ampere-turns should remain the same. Again. Mr. Ravenshaw's rule would, when applied to similar machines, give the ampere-turns on armature proportional to the square of radial depth of core, whereas on slip 12 this was shown to be proportional to the first power of the depth.

Prof. Ayrton said he was particularly interested in Mr. Esson's paper, because it contained so many experimental results. Referring to Mr. Swinburne's method of treating the subject, he deprecated the use of the term "magnetic potential" where difference of magnetic potential was meant. He also thought Mr. Esson's term "working saturation," slip 3 and 4, was not to be recommended, and that 'working induction" would be much better. In his further remarks, the professor said he would confine himself chiefly to three heads, which were brought out prominently in a paper on "Electro-motors," by Prof. Perry and himself in 1883, and about which considerable difference of opinion still existed. These were—first, the existence of magnetic lag; second, the alteration of resistance of revolving armatures by self-induction; and third, motor construction for minimum weight. As regards magnetic lag, this, he said, had often been denied, but quite recently Prof. Ewing had shown that such lag did occur, amounting in some cases to several minutes. With reference to the increased resistance of revolving armatures due to self-induction, he thought some misunderstanding existed, for Mr. Swinburne in his paper says that "power cannot be lost by self-induction. In their original paper Prof. Perry and himself had given a formula for calculating this loss when the brushes were placed at the neutral position, and this they confirmed experimentally. When, however, this condition is not fulfilled a modification is necessary. If the brushes could be placed at an absolutely non-sparking position the resistance of the armature would not be increased by rotation, for then a section leaves the brush and is thrown into circuit with the proper current in it, and hence no further E.M.F. is needed to bring the current up to its proper value. In fact, the energy used in starting the current is supplied by the belt whilst the coil is short-circuited. He also said that in a dynamo with sparkless lead the coils between the neutral line and the brushes acted as motor coils and assisted the rotation of the armature, whereas in a motor they act as dynamo coils and oppose the rotation. Before passing to the third heading reference was made to some remarks of Mr. Esson in the discussion on Mr. A. T. Snell's paper of "Design of Motors," read before the City Guilds Old Students' Association last year. Mr. Esson there said that the chief use of the series winding in compounded Manchester dynamos was to counteract the demagnetising action of the armature. To test this experiments had been made on such a machine, and it was found that out of 10,500 ampere-turns required at full load, 2,660 were required to compensate for back induction and 2,100 for loss due to resistance of armature. Commenting on the best relation of iron to copper in armatures (slip 17), Prof. Ayrton thought it a mistake to assume constant induction in the armature, for an increase of copper would mean greater excitation. Taking the excitation as fixed, Prof. Perry and himself had shown (*Proc.* Phys. Soc., vol. ix., p. 220) that maximum output was obtained when the magnetic resistance of the space occupied by copper was equal to that of the rest of the circuit. As regards the question whether motors should or should not be made different from dynamos, the speaker said that in an Immisch series motor run as a dynamo and as motor at the same speed and current, the E.M.F., neglecting self-induction, was 14 per cent. greater as a motor, and when the maximum possible effect of self-induction was allowed, a difference of 10 per cent. still remained. This had since been confirmed by measuring the induction in the field-magnets, both when a current was sent through the magnet-coils alone, and then through both magnets and armature, the latter revolving at 1,400 revolutions as a motor. In the latter case the induction was 5 per cent. greater than in the former. Experiments on the characteristics of a magneto Gramme used as a generator and as a motor with equal lead and trail, show that as a dynamo the curve falls as in Fig. 15 of Mr. Esson's paper, whereas as a motor the curve rises with increase of current. On trying the same experiments with a separately-excited A Gramme, the E.M.F. as a motor always increased with the current through the armature, whatever the strength of exciting current used, but as a generator the E.M.F. always decreased, and with a weak field became negative when the armature current increased. In conclusion, Prof. Ayrton contended that the above experiments, as well as those of Mr. Esson, on the Bürgin machine, proved conclusively that a relatively powerful armature strengthens the field of a motor, and weakens that of a dynamo.

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* Paper read before the Institution of Electrical Engineers, Feb. 20, 1890.

Mr. Ravenshaw said that apart from their own merits Mr. Swinburne's and Mr. Esson's papers would be most useful in promoting discussion on the causes of sparking. As regards Mr. Esson's expression for the ampere-turns which may be carried on an armature, he could not say that it held good in practice. He himself had experimented a good deal on the subject, and the results seemed to point to the fact that for all sizes and shapes of well-designed machines, their behaviour at the brushes would be very similar when the ratio between the ampere-turns and the total induction in the armature was the same. This he gave not as a law, but as a result of his own experience. That experience, however, did not agree with that of Mr. Esson. One machine, made for 4,000 watts, on which he had made many experiments, had a very small distance between the pole-pieces and armature core, and the pole-pieces were rather close together. After testing it under these conditions up to 6,000 or 7,000 watts, he tried it with the field bored much larger and also with the poles cut off until they embraced an angle of 90deg. Under all these conditions the maximum ampere-turns it would carry without sparking appeared to be the same, the armature induction being kept constant. This machine was afterwards wound with a drum armature and he had built two other types of machines with the same area of armature core, both of which carried the same ampere-turns.

Dynamo.	Kilowatts.	Mr Esson's coefficient.	$\frac{\text{Ampere-turns}}{\text{Armature core area.}}$	Armature.
1. Four-pole	16	40,000	31	Gramme.
2. Under type ...	16	50,000	32·5	
3. Gramme field	16	70,000	28·5	
4. Under type ...	6·5	36,000	72	Drum.
5. Over type	6·5	62,000	67	
6. ,, ,, ...	6·5	73,000	64	
7. ,, ,, ...	46	151,000	61	
8. ,, ,, ...	46	220,000	60	

The above table shows Mr. Esson's coefficient for these three machines. According to Mr. Esson No. 4 should have carried double the ampere-turns on No. 6, but as a matter of fact No. 6 sparked decidedly the least. No. 8 was built when copper was very expensive, and was in all other respects the same as No. 7, excepting that it had a large armature, large polar surface, and a very short air space. Both machines were sparkless, but began to spark at about 50 per cent. above full load. Nos. 1, 2, and 3 were of entirely different design, agreeing only in the area of armature core. They all behaved in exactly the same way at the brushes when working with the same number of ampere-turns on the armature. All the eight machines sparked a good deal with 50 per cent. more load than that given in the table. Mr. Esson had said that if the length of the armature was increased the ampere-turns must be kept constant. In reply to this, Mr. Ravenshaw said he built all his machines in sets of three, the only difference between the largest and smallest of each set being in the length of the armature and magnet cores, and the ampere-turns on the armature were increased in the same proportion. In Gramme armatures the output was limited by sparking, but with drums it was limited by heating, for the ampere-turns which could be carried by the latter were at least double those of the former. Speaking of magnetic leakage, Mr. Ravenshaw said most engineers seemed to think it impossible to calculate it with certainty, but this was erroneous, for he had been in the habit of calculating the leakage from the drawings for some years past, and always obtained accurate results. This is important, as he finds that the leakage may be as high as 45 per cent. and as low as 20 per cent.

Mr. Kapp stated that the two papers under discussion would form very important landmarks in the development of the dynamo, and said the subjects treated in them had been brought into prominence by the use of large machines. According to Mr. Swinburne, the limiting diameter of armatures in two-pole machines was about 40 centimetres, but he (Mr. Kapp) had, by increasing the dimensions of all the parts proportionately, made dynamos with 50-centimetre armatures, and others had gone still higher. Referring to formula (2) in Mr. Swinburne's paper, he asked whether the coefficient, M, was correct, for as given, the length of the armature was not taken into account. His own experience gave coefficients varying from 0·12 to 0·18 instead of from 0·08 to 0·085. He also found that the magnetic leakage resistance in English measure for two-pole dynamos of the upright type was expressed by the formula $\frac{680}{\sqrt{ld}}$ and for the inverted type by $\frac{460}{\sqrt{ld}}$ where l and d are the length and diameter of the armature in inches. As regards reversing pole-pieces, he said that they were brought out about five years ago by Mather. Coming to Mr. Esson's paper, Mr. Kapp wished to add one device for equalising the field in single-magnet machines which had been omitted from the interesting collection on slips 4 and 5. This device consists in making the upper horns to Fig. 7 rather longer than the lower ones. As regards the ratio of armature to field-section dealt with on slips 6 and 7, he thought the remarks there made were only applicable to badly-designed machines, for in good dynamos there was no room for such radical changes. The agreement of Mr. Esson's coefficients in Table II., he said, was rather surprising at first sight, but on examining the formula it may be seen to be equivalent to saying that the maximum ampere-turns on an armature may be proportional to the ampere-turns on the field-magnets required to produce a given induction in the armature, a not unnatural conclusion. His own opinion was that both Mr. Esson and Mr. Ravenshaw loaded their machines too heavily. As a rough rule he found that the expression ampere-turns on armature $= 1{,}000\,(d-5)$, where d is the diameter in inches, agreed very well with his practice. He cordially endorsed Mr. Esson's remarks on the small rise of temperature allowed by the Admiralty, for a rise 11deg. C. meant enormous machines for their output. On the other hand, he usually allowed more cooling surface than Mr. Esson, his rule being 1·5 and 2·5 square inches per watt wasted in armature and magnets respectively. Referring to the relation between size and output, Mr. Kapp thought the exponent 2½ given by Mr. Esson was rather low, for from actual tests on machines with armatures varying from 7in. to 13in. in diameter he found that for Gramme winding the output varied from $d^{3\cdot3}$ to $d^{3\cdot7}$ and for drums from $d^{3\cdot3}$ to $d^{3\cdot9}$.

Mr. Farquharson said he thought the Admiralty rule for limiting rise of temperature had been misunderstood, and in Mr. Esson's paper it was wrongly stated, for the rise permitted was 30deg. F. and not 11deg. C. The method of testing adopted by the Admiralty was to take the temperature outside the insulation immediately the machine was stopped. This temperature was by no means the same as that within the conductor, for he had known the outside temperature to rise for 20 minutes after the machine was stopped. Keeping this fact in view, together with the long continuous runs (sometimes amounting to 24 days and nights) to which ship-lighting dynamos may be subjected, he thought the Admiralty were justified in fixing the limiting temperature low enough to be safe for all machines. As a proof that the rule was not impracticable, he mentioned that all of 12 machines already delivered this year were well within the limit allowed.

Mr. A. T. Snell, speaking of machines run as dynamos and as motors, said he always found it possible to get a greater output at a given speed when running as a motor, and that the trail as a motor was always less than the lead as a dynamo. In fact, with motors used for tramcars they worked without lead and run in either direction with the same pair of brushes. Another point in which motors differed from dynamos was the possibility of using very thick brushes with advantage in the former, whereas in the latter such a proceeding proved disastrous. These differences seemed to him to show that the magnetic distributions in generators and motors are not the same, and that in dynamos the field was more straggling and subject to greater distortion. Referring to Mr. Esson's formula for the loading of armatures, Mr. Snell said he had tested it on machines with which he was acquainted, and, although he found a certain agreement, this was by no means so close as the numbers given in the paper. He himself had been in the habit of using the formula,

$$\text{Electrical horse-power} = l\,d\,n\,\text{K},$$

where l and d are the length and diameter of the armature, n the speed, and K a constant, and this gave close approximations where the armatures have the same proportions. Alluding to rise of temperature in large machines after long runs, he mentioned that in some machines designed to work between 50 h.p. and 100 h.p. this amounted to 50deg. F., the temperature being taken on the wire on the inside of the cylinder armatures.

The discussion was then adjourned to the 13th inst.

At the meeting on the 13th inst. **Prof. Ayrton** exhibited curves representing results of experiments on the Gramme magneto and Gramme dynamo when run as motors and generators, which he described on the 27th ult. Another curve showed similar results obtained with a Manchester dynamo separately excited with half its normal current. In this machine, run as a generator with a lead of 11deg., the E.M.F. decreases with increase of current in the armature, whereas when run as a motor with a trail of 11deg. the E.M.F. rises under the same conditions. From these observations he concluded that Mr. Swinburne and Mr. Esson were wrong in saying that the back E.M.F. in a motor could not be greater than the forward E.M.F. in a dynamo working under the same conditions as to speed and current. The secret of obtaining this increased E.M.F. in motors was, he believed, the employment of a relatively powerful armature.

Mr. Willans, referring to Mr. Esson's remarks on slip 4 relating to the magnetic pull on armatures of single-magnet machines, said the inverted type there described (Fig. 5) was the worst that could be adopted, for by employing those of the upright type (Fig. 4) the magnetic pull could be caused to support the weight of the armature, and the supposed defect converted into a distinct advantage. Speaking of the Admiralty temperature limit criticised by Mr. Esson and Mr. Kapp, he said that in testing the combined efficiency of engines and direct-driven dynamos they had, with machines that run cool, obtained 84 or 85 per cent. of the indicated horse-power available at the dynamo terminals. On the other hand, machines that get hot never yielded more than 70 per cent. Whilst agreeing with the Admiralty that the rise of temperature allowable should be small, he objected to the method of taking the temperature; this method he characterised as being more a test of the heat conductivity of the insulation and thermometer than of the temperature of the machine.

Prof. Forbes said both authors had touched upon very important points which had not been previously discussed in public. As regards Mr. Swinburne's paper, he said non-mathematical readers should not accept unreservedly all the conclusions there arrived at, for some of them are admittedly based on approximations and assumptions which are not always fulfilled in practice. Nevertheless, he considered the treatment a step in the right direction. He could not accept Mr. Swinburne's statement that self-induction *prevents* waste of power, for all sparking is due to self-induction, and consequently it *causes* a waste of power. Another point about which he had grave doubts was the efficacy of the method of throttling cross induction shown in Figs. 3 and 4. His own (Prof. Forbes) opinion was that such methods would tend to concentrate the lines about B and D, whilst the field at A and C would be relatively weak. He also thought that by partly filling up the space at E a greater induction through the armature would be obtained. Referring to reversing pole-pieces described on slips 8 and 9, he thought them ingenious, but open to considerable objection, and believed other and better means of preventing sparking would be devised. Coming to Mr. Esson's paper, he said the remarks on slip 2 respecting the utility and accuracy of calculating the waste field were directly opposed to his own opinion on the subject, and also to the experience of Mr. Ravenshaw. This point, he thought, gave a good instance of how some self-designated "practical men" object to spend the few hours necessary to calculate the waste field and prefer spending a month's labour in making a machine, with all its attendant expense, in order to obtain experimentally results which could have been readily derived by calculation. Prof. Forbes congratulated Mr. Esson on the many experimental results given in his paper, and on the valuable and interesting way in which he had treated the subject of loss by hysteresis, illustrated by Fig. 14, and the distortion of the field produced by the armature current. His own experience with non-commutating dynamos had brought the latter phenomenon prominently before him, for he had found the E.M.F. at full load to be about half its value at no load. This he attributed to the fact that a given demagnetising force produces a much greater change of induction than that produced by an equal magnetising force when the iron is not saturated. Referring to the loads carried by armatures (slip 10) he considered that the limit should not be fixed by sparking, but rather by questions of heating and efficiency. Armatures designed on the latter lines should then be examined by the light of Mr. Esson's formula, and if they do not satisfy the non-sparking condition must be modified accordingly.

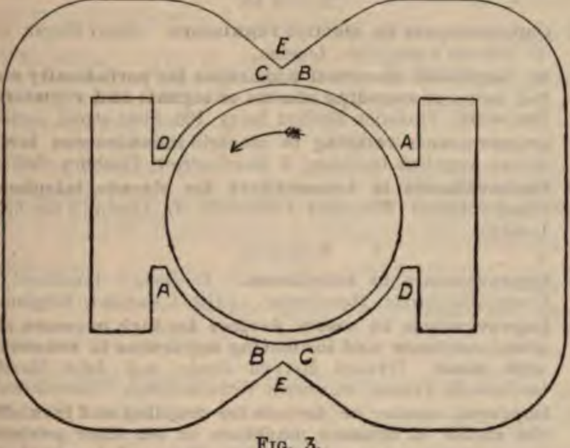

Fig. 3.

Mr. Mordey regretted that Mr. Swinburne's paper was not printed so fully as it was read. He did not agree with Prof. Forbes as to the result of reducing cross induction by the methods shown in Figs. 3 and 4 of Mr. Swinburne's paper; in fact, he considered the plan quite natural, and it was very effective in well-designed machines. He thought that subsidiary or reversing pole-pieces would not be practical and that sparking is generally due to overloading; a better plan of preventing sparking would be to utilise the additional length of armature which the pole-pieces require, for lengthening the main core, thereby reducing overloading.

Mr. Swinburne here pointed out that the devices were not merely to prevent sparking but to reduce the back turns, thus diminishing or rendering unnecessary the series winding on machines for constant E.M.F.

Mr. Mordey (continuing) referred to "small air space dynamos" (slip 12), and said Mr. Swinburne was once a great advocate of such machines as well as of "large output dynamos." However, as far as he was aware, no great progress had been made with either variety, for makers seem to have come back to machines having moderate air spaces and of moderate output. Speaking of "high-tension constant-current dynamos," he said many difficulties were met with in smooth commutator machines under varying load. The Brush machine had been tried shunt-wound, but it would not excite at small loads, and at large loads it flashed round. The supposition as to the cause of excessive heating of the trailing horn given on slip 13 was not satisfactory, for the same corner heats if the machine be run as a motor, only not quite so much. The effect is probably due to the magnetic tufts from the Pacinotti projections. In discussing methods of measuring temperature of machines, he said this was sometimes done by measuring the resistance of the armature when hot, but this was not to be relied upon, for, owing to expansion and consequent change of contact resistance at the soldered joints, the resistance hot might be less than when cold. Referring to Prof. Ayrton's remarks on the construction of "light-weight motors," Mr. Mordey said such machines were like "large-output dynamos," in not being successful in practice. He then read abstracts from Profs. Ayrton and Perry's paper on "Electromotors," &c., which, in his opinion, had retarded rather than advanced motor design. He contended that both in dynamos and motors an armature which produces no appreciable field is the best. As regards "magnetic lag," he said that any such lag of practical importance would prevent E.M.F. being proportional to speed. Experiments on a Victoria Brush machine showed that from 200 to 1,200 revolutions per minute the E.M.F. curve was a straight line in spite of eddy-currents, which increase as the square of the speed.

Prof. Ayrton here remarked that Dr. Thompson, who agrees with Mr. Mordey as to the non-existence of magnetic lag, entirely disagrees with him on the question of E.M.F. being proportional to speed.

Mr. Mordey, in reply, said he was not answerable for Dr. Thompson's statements, but he was quite sure that in well-made machines he had tested the E.M.F. was exactly proportional to speed.

Mr. Sayers questioned the accuracy of Mr. Swinburne's view of the action of coils short-circuited by the brushes given on slip 11, and thought the various statements were not consistent. The real effect was a diminution of the induction in dynamos and an increase in motors. He had made many experiments on the subject, and invariably found that for a given speed and current the E.M.F. of a machine run as a motor was greater than when used as a dynamo, and the same thing is shown with one solitary exception in Table IV. of Mr. Esson's paper. Laminating the cores has the effect of decreasing the divergence. One serious cause of sparking which had not been referred to in either paper was the want of accuracy in making all the sections and commutator bars exactly alike, and spacing them with rigorous exactness round the armature. In his opinion nothing short of the accuracy obtained by engineers in cutting wheels would effectually overcome sparking. Neglect of such precaution causes variation in the non-sparking position, the result of which may sometimes be seen in some segments being marked whilst the other remain perfect.

Mr. Crompton said he wished to bring forward a few novelties not mentioned in either of the valuable papers under discussion, for although these papers deal with many interesting and important points in dynamo design, they do not say how the best machines of the day are being made. Several firms—notably Messrs. Siemens—he said were turning out dynamos having efficiencies undreamt of several years ago. The results mentioned by Mr. Willans, for example, of a combined engine and dynamo efficiency of 84 or 85 per cent. showed that the commercial efficiency of the dynamo must be quite 93 per cent. The cause of the high figure, he believed, was to be found in the much-abused Admiralty specification; for all firms anxious to secure contracts had been obliged to devise means for reducing the rise of temperature, the result of which was greatly increased efficiency. In making large machines, difficulties presented themselves which were unimportant in small dynamos; for example, as pointed out in Mr. Swinburne's paper, the magnetic leakage across the internal cavity of Gramme armatures becomes serious. On the whole, he was inclined to agree with Mr. Swinburne's remarks on the disadvantages of Gramme as compared with drum armatures. Some doubt, he said, still exists as to the necessity of insulating the driving hubs of drum armatures from the shaft; in his opinion it was not necessary. The question as to what material should be used for transmitting the driving strain from the shaft to the armature required careful consideration; he himself found aluminium bronze and Delta metal fairly satisfactory, for they combine good mechanical strength with high electrical resistance. Another point requiring particular attention was the subdivision of the armature conductors in machines for large currents. The heating of the conductors in "bar armatures" due to Foucault currents may be considerable, but by subdividing the bars into sections and twisting them through half a turn he had succeeded in largely reducing this effect to about half its former value. A further improvement consists of forming the conductor from a great number of wires twisted together and compressed into a trapezoidal form of the proper shape for the winding. In illustration of the various methods of subdivision above referred to, Mr. Crompton exhibited specimens of conductors made by his firm. Speaking of the arrangement of the radiating surfaces on armatures, he said the question, "Does it pay to cover all the surface of the core with copper or to leave spaces between the sections to give increased surface?" was still open to discussion. Referring to Mr. Mordey's statement about the lessened resistance of hot armatures, he said he had never observed such an effect, and thought the joints in machines exhibiting such peculiarities must have been defective. In conclusion, Mr. Crompton replied to Mr. Esson's remarks on slip 12, respecting dynamo No. 4, Table II., by saying that this was the first machine in which the design had been influenced by the idea of magnetic resistance, and he was glad to see that its armature was the father of all modern ones of the Gramme type. In support of this, he pointed out that the ratio of radial depth to diameter was one to five, a proportion now almost universally adopted.

The discussion was then adjourned to the 20th inst.

West India and Panama Telegraph Company.—The estimated receipts for the half-month ended March 15 were £5,302, against £3,628.

Western and Brazilian Telegraph Company, Limited.—The receipts for the week ended March 14, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,485.

NEW COMPANIES REGISTERED.

Foreign and Colonial Electrical Power Storage Company, Limited.—This Company has been formed with a capital of £100,500 in £5 shares to acquire certain foreign and colonial patent rights for inventions relating to the storage and supply of electricity by batteries or accumulators upon the principle known as the "E.P.S." system. It is proposed to purchase these rights from the Electric Construction Corporation, who now hold them, and who are the promoters of the Company, for the sum of £75,000, payable in cash or shares at the option of the Company. One hundred of the shares are founders', which will receive no dividend in any year until the ordinary shares have received 8 per cent. for that year. Letters of allotment in this Company have been posted.

Elmore's Patent Copper Depositing Company, Limited.—This Company invites applications for 100,000 shares of £2 each, at a premium of £1 per share, in Elmore's Wire Manufacturing Company, Limited, which has been formed with a capital of £300,020, in 150,000 ordinary shares of £2 each and 10 founders' shares of £2 each, to acquire the exclusive British license to make all kinds of metal wire, ribbon, tape, and rod by the Elmore processes, with the sole right to grant sub-licenses for the same. The prospectus states that the Company is formed pursuant to the original intention of the licensing company, which was to have a separate company and capital to carry out the work that would be offered to the wire-manufacturing department. The purchase money to be paid by the Company to Elmore's Patent Copper Depositing Company, Limited, is £75,000, and half the amount of premiums received by any issue of shares, and also the allotment of the 10 founders' shares of £2 each.

Keys' Electric Company, Limited.—Registered by Tamplin, Tayles, and Joseph, with a capital of £15,600, divided into 3,000 ordinary shares of £5 each and 600 founders' shares of £1 each. Object: to carry on the business of electrical and mechanical engineers and manufacturers of, and wholesale and retail dealers in, all apparatus and things required for, or capable of being used in connection with, the generation, distribution, supply, accumulation, and employment of electricity; to manufacture, use, sell, license, hire, and deal in any engines, machinery, or things necessary for the business of the Company. The first subscribers are:

	Shares.
J. H. Ward, 22, Lower Phillimore-place, W.	198
F. Deutsch, Warnford-court, E.C.	198
J. W. Keys, 42, Lambeth-road, S.E.	50
A. A. Blake, 29, Aldred-road, S.E.	1
T. Lane, 10, Ennis-road, N.	1
R. Hall, 54, Norfolk-road, N.E.	1
E. T. Hamilton, 59, Sutherland-square	1

The number of the Directors shall be not less than two nor more than four. The first Directors shall be two in number, of whom one shall be appointed by John Henry Ward, one of the subscribers to the memorandum, and the other by Franz Deutsch, another of such subscribers.

PROVISIONAL PATENTS, 1890.

MARCH 10.

3778. **Improvements in the manufacture of paper or tape coils adapted for use in telegraphic printing instruments.** Morris Hart, 191, Fleet-street, London.

3787. **Improvements in electric railways.** Hosea W. Libbey, 45, Southampton-buildings, London. (Complete specification.)

MARCH 11.

3805. **Improvements in electrical terminals.** Walter Brierley, Central-chambers, Halifax. (Heinrich Arld, Germany.)

3839. **Improved receiving apparatus for cable telegraphy.** Patrick Bernard Delany, 24, Southampton-buildings, London.

3840. **Regulation of alternating generators.** Stanley Charles Cuthbert Currie, 24, Southampton-buildings, London. (Complete specification.)

3841. **Automatic apparatus for compensating variations of current in electric conductors.** Siemens Brothers and Co., Limited, 28, Southampton-buildings, London. (Alfred Mills Taylor, India.)

3842. **A circuit breaker for secondary currents from electrical transformers.** Siemens Brothers and Co., Limited, 28, Southampton-buildings, London. (Alfred Mills Taylor, India.)

3860. **Improvements in electric light fittings.** Druitt Halpin and Illius Augustus Timmis, 2, Great George-street, Westminster.

3861. **An improved holder for incandescent lamps.** Ben Death, 62, Morrison-street, Shaftesbury Park, London.

MARCH 12.

3900. **Improvements in insulation and cooling of electrical inductoria.** Lazarus Pyke and Harry Theodore Barnett, Canterbury Works, Blenheim-terrace, London.

3913. **Improvements in alternate current transformers.** Gisbert Kapp, Walter Claude Johnson and Samuel Edmund Phillips, 28, Southampton-buildings, London.

3924. **Improvements in electric batteries.** Henry Harris Lake, 45, Southampton-buildings, Middlesex. (The Crosby Electric Company, United States.) (Complete specification.)

MARCH 13.

3937. **Improvements in electric flash signalling lanterns and apparatus in connection therewith.** W. Stepney Rawson and C. Scott Snell, 88, Queen Victoria-street, London.

3947. **Improvements in the manufacture of light emitters or illuminants for electric or other lamps.** James Clegg, Connaught-mansions, Victoria-street, Westminster.

3963. **Improvements in and relating to electrical switches.** William Scott, 96, Buchanan-street, Glasgow.

3967. **Improvements in or connected with the manufacture of secondary battery elements.** James Shannan Stevenson, 47, Lincoln's-inn-fields, London.

3969. **Improvements in switchboards for stations of electrical supply.** Siemens Brothers and Co., Limited, 28, Southampton-buildings, London. (Alfred Mills Taylor, India.)

3984. **Improvements in or connected with shades, globes, or glasses for electric or other lights.** Alexander Duval and Henri Nelson, 46, Lincoln's-inn-fields, London.

MARCH 14.

4000. **Improvements in electric regulators.** Henri Pieper, Fils, 47, Lincoln's-inn-fields, London.

4011. **An improved electrical apparatus for periodically ringing bells, or sounding alarms or signals and registering the same.** Frederick Herbert Berry, 186, Fleet-street, London.

4025. **Improvements relating to electric incandescent lamps.** Albert Augustus Goldston, 4, South-street, Finsbury, London.

4028. **Improvements in transmitters for electric telephones.** Charles Lionel Wingfield FitzGerald, 47, Lincoln's-inn-fields, London.

MARCH 15.

4043. **Improvements in telephones.** Ferdinand Bosshardt, 4, Corporation-street, Manchester. (Alfred Mattard, Belgium.)

4053. **Improvements in safety devices for high pressure electrical currents and indicating apparatus in connection with same.** Bernard Mervyn Drake and John Marshall Gorham, 2, Princes'-mansions, Victoria-street, Westminster.

4086. **Improved means or devices for coupling and insulating the shafts of dynamo machines or for other purposes, where parts are required to be connected together and insulated from each other.** Clement Johnson Barley and Hew Stevenson, 47, Lincoln's-inn-fields, London.

4087. **Improvements in secondary voltaic batteries.** Henry Tyrer Cheswright, 28, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED

1888.

10437. **Printing telegraphs.** Wright and Moore. (Reprint with alterations.) 11d.

7655. **Electric conducters.** Crompton. (Second edition.) 1s. 1d.

1889.

3363. **Incandescence electric lamps.** Edmundson. 4d.

5066. **Incandescent electric lamps.** Newton (Swan). 8d.

5623. **Telegraphic apparatus for transmitting orders, &c.** Calvert. 11d.

5976. **Electric alarm clock.** Leyland. 8d.

6728. **Distributing electric energy.** Kapp. 8d.

6745. **Electrolysing substances in fusion.** Kiliani. 8d.

7600. **Electric indicators.** Cant. 6d.

8958. **Electric meter.** Frager. 11d.

16816. **Electro medical apparatus.** Harness. 8d.

17611. **Electro medical apparatus.** Harness. 6d.

18638. **Driving electrical vehicles.** Dickinson. 6d.

20260. **Electric semaphores.** Stitzel and others. 8d.

1890.

941. **Electric tramways, &c.** Lineff and Bayley. 11d.

950. **Dynamo machines.** Thompson. 6d.

1028. **Converting a direct into an alternating electric current.** Thompson (Gutmann). 8d.

1094. **Secondary batteries.** Lake (Ewing). 6d.

1110. **Galvanic batteries.** Hitchcock (Burnley). 6d.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Anglo-American Brush	—	2½
— Pref.	—	1⅞
India Rubber, Gutta Percha & Telegraph Co.	10	18⅞
House-to-House	4½	5
Metropolitan Electric Supply	—	6
London Electric Supply	5	3
Swan United	3½	5
Telegraph Construction	12	45
— 6%, 1889	100	105
National Telephone	5	5¼

NOTES.

The World's Fair.—It has been decided at Washington to put off the Great World's Fair till 1893.

Taunton.—The public account for lighting streets at Taunton for four months, ending Dec. 31 last, amounted to £219.

Telegraphic Congress.—The French Chamber has voted 100,000f. for the International Telegraphic Congress to be held at the Louvre in June.

Popp System.—It is stated that the Municipality of Hamburg is considering the introduction of the Popp system of distribution by compressed air.

Florence.—The Municipality of Florence has entered into a contract with the Italian Edison Company for the electric lighting of the principal streets.

Electric Railway.—A company has been organised at Pittston, Pennsylvania, to build an electric railway 30 miles long from Wilkesbarre to Pittston and Scranton.

Dresden.—Messrs. Siemens and Halske have received the contract for the electric lighting of the town of Dresden, the generating station to be situated outside the town.

Alpha Arc Lamps.—The Continental Edison Company have just installed at the torpedo works, Castignau, near Toulon, 10 of Macquaire's "Alpha" arc lamps and 200 incandescent lamps.

Electric Car Rules.—Mr. Jos. Stanley, president of the Broadway and Newburgh electric tramway, Cleveland, has lost his life through disobeying his own rules as to not getting off the car from the front platform.

Indian Telegraph Service.—The report of the Indian Telegraph Department for the past year shows a surplus of Rs.19,80,245, representing a dividend of 4·45 per cent., which is the highest yet recorded.

French Exhibition.—We hear that the Gulcher Electric Light Company, of Battersea, have obtained the whole of the lighting of the French Exhibition this year to be held at Earl's Court, which is a proof that they were fully appreciated last year.

The Highest Telegraph Office.—In the Sikkim expedition a telegraph office was opened which enjoys the distinction of being the highest in the world. It is situated at Bhutong at an altitude of 13,500ft., nearly two and three quarter miles above the level of the sea.

Indian Telegraphs.—A telegraph line is to be constructed between Quetta and Apozai, the head-quarters of the new Zhob Valley district. No doubt in time, says the *Indian Engineer*, there will be direct communication between Dera Ismail Khan and Apozai through the Gomal Pass.

Electric Welding.—The favourable report of Prof. Kennedy on the process of electric welding in America is creating considerable interest in many business and engineering quarters. We understand that Sir Frederick Abel is to give a paper on the subject before the Royal Institution shortly.

Ferranti System in France.—A central electric lighting station has recently been started at Sens (Yonne). The plant, which is sufficient for 3,000 lamps, consists of a Brasseur steam-engine, a Ferranti dynamo by the Compagnie Nationale d'Electricité, and various accessories by Messrs. Cuenod-Sautter.

Creeping of Batteries.—A simple method of curing the troublesome creeping of salts on batteries is described by M. Ernest Gerard. This is to smear the surfaces to be preserved with a thin coat of vaseline. The vaseline is unchangeable by air, is not attacked by most chemicals, applied easily, keeps in place, and does not cover up from sight the parts to be protected.

Editorial Changes.—The well-known editors of the American *Electrical World*, Mr. T. Commerford Martin and Joseph Wetzler, M.E., have left that journal and have associated themselves with the New York *Electrical Engineer* as its editors, at 150, Broadway, New York. Henceforth its editorial conduct will be in their hands, and the paper will be issued as a weekly.

Metropolitan Fire Brigade.—The next fire brigade station opened by Lord Rosebery on Monday, in East-street, Marylebone-road, will be the chief headquarters of the A division of the brigade, which comprises Marylebone, Hampstead, Westminster and Fulham. The new station will be in communication by telegraph, telephone, or electric bells with 13 minor stations in the districts indicated.

Supply of Power.—It is reported that Mr. Henry Villard is organising a large company in New York for manufacture of electric machinery and supply of power near Minneapolis. Three sets of dams are to be erected, and local manufacturers are to be supplied with power at a price equal to that from coal at two dollars a ton. The manufacture of electric motors and machinery is to be a great feature.

China.—The electric lighting company for China of which we spoke some weeks ago has been floated, and the necessary plant has been taken from San Francisco to Canton to light that city. The new viceroy, Li Han-Chang, has issued a proclamation that no impediment be placed in the way of the engineers, and points out that, besides the better illumination, far greater safety from fire will be secured to the inhabitants.

Backstrom Incandescent Lamp.—A new incandescent lamp is introduced by Seeley and Taylor, New York. The carbon filaments are made from raw silk thread put through a careful process and capable of bearing high temperatures. A suspended needle is fitted inside from the socket to the glass tip. This both prevents shaking, and also, it is stated, obviates discolouration, as the particles of carbon are attracted to this.

Boston Electric Cars.—During a recent snowstorm in Boston, U.S., the electric tramcars showed to great advantage over the horse-cars. While the latter required four horses and could only proceed at a snail's pace, the electric cars glided along with scarcely perceptible diminution of speed, and even where the snow has been up to the pans under the motors the cars have gone along almost as quickly as if the track had been clear.

Electricity on the Pacific.—Electric lighting on the Pacific Coast seems to have progressed rapidly during the last year. The Thomson-Houston Electric Company installed 11 alternating plants with a capacity of 6,900 lamps in California and Nevada, seven direct incandescent plants aggregating 1,930 lights, and nine plants supplying 445 arc lights. The Edison Company also had a prosperous year, for its report shows that 16 central stations were established on the coast with a capacity of 11,945 lamps. Twenty-four isolated plants were also installed. The combined capacity of these plants is 6,690 lamps.

Tramway Sprinkler.—A street sprinkling system is in use in some of the towns of America, amongst others Louisville, Kentucky. A pierced pipe stretches out a certain distance on one side of the car, which is run at some speed along the line, sprinkling the whole line. The tramway company have a contract with the city for the watering, and in this way make the line pay a good deal better. The sprinkled streets in summer are far more pleasant; the streets, if kept wet, it is found lessen the power to drive the cars. Each car carries 1,800 gallons, and sprinkles six miles of streets, and this on a line with a 2½ minute service.

Concert.—On Thursday evening, the 20th inst., a smoking concert was held at the Sir John Falstaff Concert Hall, Old-street, E.C., by the Ferranti String Band, at which about 600 of the engineering staff and employés of S. Z. de Ferranti, Esq., and of the London Electric Supply Corporation were present. Many of the engineers of several of the more prominent electric lighting companies of the metropolis were present. The occasion was taken to present Mr. Sparks (Mr. Ferranti's partner) with a handsome address and a tea and coffee service from the united engineers' staff and employés of the above firms, on the occasion of his approaching marriage.

Discovery and Application.—The Italian technical and industrial journal, *L'Elettricita*, published in Milan, has addressed an enquiry to persons conversant with the subject to kindly reply, either through our medium, or direct, to the following questions: (1) What invention, discovery, or scientific study has been the most important during the year just passed in the domains of electricity; (2) which application of electricity, already known, may be expected to most progress and extend during the present year. It is intended to publish the replies received in a pamphlet, to be issued in April from the office of the said journal. Readers of this note are therefore invited to send their ideas upon these interesting questions.

Electric Boats at the Boatrace.—Electric launches are now an indispensable feature of any nautical gathering on the Thames, and at the Oxford and Cambridge boatrace on Wednesday the electric boats were, after the race itself, one of the most noticeable features. Messrs. Immisch had several large launches, among which the "Alpha," of the *Daily Graphic*, was conspicuous. One of Messrs. Immisch's charging stations was moored along the reaches. Mr. Sargent had several small electric pleasure-boats which flitted silently about among the throng, or rung the warning electric bell as they turned. The interest created in these boats is evidence of the correctness of the views of the manufacturers as to their popularity in the coming season.

Brussels.—The action of the Municipality of Brussels with regard to electric light concession is still causing very heated discussions. M. Flamuche, secretary of the Brussels Engineering Society, at a recent meeting energetically condemned the concession to the Liege agents of Messrs. Siemens, and protested both against the term of 35 years and the exclusive use of a low-tension system as costly both in maintenance and capital expenditure. A resolution was unanimously adopted that the public assembly express the resolve that the town of Brussels should not concede exclusively and for a long term the electric lighting of the capital, and that they leave a way open for further progress in the science by reserving the right of further concessions if the general interest of the town required it.

Electric Light in Hyderabad.—It has been definitely settled, according to a correspondent of the *Indian Engineer*, to light the whole town of Chudderghaut with electricity, and if the trial should prove successful, the Cantonment Committee of Secunderabad will then adopt steps to introduce the electric light in all the principal thoroughfares of that military centre. The lighting arrangements of Secunderabad have always been pronounced defective, and the introduction of electricity in place of kerosene will be a decided improvement and advantageous to the public in more ways than one. Financially, the change has also been discovered to work with less cost, and from an administrative point of view will, in the long run, develop the resources of these large towns and add to their importance.

Obituary.—We greatly regret to learn of the death, at Berlin, of Herr Johann Georg Halske, the co-founder and, for many years, partner of the well-known firm of Siemens and Halske. He was born at Hamburg on July 30, 1814, and went to Berlin, where he set up an engineer's shop in 1844. Soon after he made the acquaintance of Werner Siemens, and it was in Halske's workshop that Werner Siemens, assisted by the mechanical skill of the former, was able to work out his first inventions in telegraphy, so as to bring them before the public. In 1847 the two men entered into partnership, and laid the foundation to the telegraph construction works which at the present day give employment to thousands of workmen both at Berlin and Charlottenburg and at several branch establishments. Halske left the firm in 1867, and since then has been an active member of the Municipality of Berlin.

Electric Station at Holloway.—Extensive new premises have been lately opened by Mr. W. Beale, contectioner and refreshment contractor, of Holloway. These form a handsome building, having frontages in Holloway and Tollington roads, six storeys high, furnished with a turreted tower, costing some £30,000. The entire premises are lighted throughout by electricity. The lighting of the banqueting hall equals 2,000 c.p., besides movable electric table lamps. There is a feature of special interest in the shape of an electrical bakery in the rear. The kitchens and pastry bakehouse are at the top of the main building. The electric current required for the establishment is considerable, and an electrical station has been erected for this purpose, which also supplies adjacent shops and public thoroughfares. Space is provided to treble the existing plant, which is now being carried out, and arrangements are at present being made for lighting the Holloway-road.

Hours and Reduction.—M. Meyer, director of the Paris municipal station of the Halles Centrales has recently published a sliding scale of prices for electric light which has given rise to some peculiar observations. The price to the consumer is 15c. (1½d.) per 100 watt-hours, if burnt more than 150 hours per month there is a reduction of 10 per cent., 180 hours 20 per cent., and 200 hours 30 per cent. The *Bulletin Internationale de d'Electricité* thereupon makes the following suggestive calculation: Taking an installation of 10 lamps of 16 c.p. each absorbing 64 watts, $\cdot 64 \times \cdot 15 \times 10$ gives ·96f. At full tariff for 149 hours, this will be $149 \times \cdot 96 = 143{\cdot}04$f. For 150 hours with 10 per cent. reduction the consumer will only pay 129·60f. If for 181 hours with the 20 per cent. reduction they will still only pay 139f.; while even if they burn for 201 hours the price will be less still—135·08f.—in the latter case paying 8f. less for 33 per cent. more light. This curious result would serve only to incite the customers to burn their lamps more than is necessary, and it is evident that the administration will have to change the published tariff to something more in accord with reason.

Sea-Going Electric Launch.—Mr. Pears' second electric launch the "Pilot" is designed as a sea-going pinnace, 26ft. 6in. by 5ft. 4in., and constructed to carry 15 people. It has been specially built for Mr. Pears by W. S. Sargeant and Co., electric launch builders and engineers, Kew Bridge charging station, Chiswick, and has a mean draught of 18in. with a displacement of 2¼ tons. The hull is carvel, built, of bright mahogany in narrow widths. As in the "Viscountess Bury" and "Pioneer," built and successfully run by the same firm, dead wood aft has been entirely abandoned with the object of obtaining greater efficiency from the propeller, facilitating steering, and reducing surface friction. The "Pilot" is steered by a tiller, and the switch controlling the electrical power is flush with the after deck and within easy reach of the steersman. Lead-lined compartments are arranged under the seats to receive 40 accumulators supplied by the Electric Construction Corporation, which are computed to hold sufficient electrical energy with one charge to propel the boat for about eight hours at eight miles per hour. The motor, which is fixed under a centre compartment in the boat, is calculated to develop three brake horse-power at 700 revolutions per minute. A clear space is left the entire length of the boat, which is quite free from danger, vibration, and the disagreeable odour naturally associated with steam-launches.

Paris Electric Tramways.—The following particulars are given of the new electric cars on the Levallois-Madeleine line at Paris. Four cars at present are running. They are fitted with Faure-Sellon-Volckmar accumulators with twin plates, 108 cells in 12 boxes containing nine each in series, each cell weighing 33lb. The 12 boxes are placed in cupboards at the angles of the cars, four in front and 12 behind. They are grouped in four groups of 27, and can be connected in four manners, one, two, three, or four in series. The motor, placed under the car, is of the Siemens type. Its speed can be 1,600 revolutions, but is usually 1,000, reduced by endless-cord gearing of 27 to 1. The reversal of the motor is accomplished by the movement of a handle fitted to the brushes; these are double, in the form of V, one branch of the V corresponding to the forward and the other to the backward motion. The car weighs 7,700lb., it carries 3,500lb. of accumulators, and can carry 50 passengers. At the normal speed of eight miles an hour, the electric energy necessary is as follows: on the level 4·5 h.p. (16 amp. × 200 v.); on a rise of 1 per cent. 8 h.p. (29 amp. × 200 v.), and 2 per cent. 11 h.p. (42 amp. × 200 v.). At the speed of 4½ miles an hour: on the rise of 3 per cent. 12·5 h.p. (46 amp. × 200 v.), and 4 per cent. 15·5 h.p. (57 amp. × 200 v.). At the speed of 3½ miles an hour: with a rise of 5 per cent. 10·5 h.p. (38 amp. × 200 v.), and 5·5 per cent. 11 h.p. (40 amp. × 200 v.).

Liverpool Engineering Society.—At the eighth meeting of this society Mr. Charles H. Yeaman, A.I.E.E., the Corporation electrical engineer, read a paper entitled "Notes on Central Station Electric Lighting." In giving an account of several stations at present supplying current on a commercial basis, he described the House-to-House system at Brompton, Eastbourne, and Brighton, the Ferranti at Glasgow, and Mordey at Bournemouth, as examples of alternating transformer plants, Hastings and Chelsea as high-tension continuous, and St. James and Pall Mall and Kensington Court as low-tension, similar to that in use in Liverpool. The paper was illustrated by mounted prints and diagrams, and also by samples of the cables and joint boxes used in Liverpool, by the courtesy of Mr. Voysey, Messrs. Callender's engineer. The history of the stations was traced, and the changes in the various systems noted. The author then compared and discussed the methods used to generate, measure, and distribute the electrical energy with regard to their general advantages, and drew conclusions therefrom as to the system of supply which will probably become general. In concluding, the author gave a short account of what is required of an electric supply company under law, with special reference to the Board of Trade, and of the curves of supply obtained from the various stations alluded to. In the discussion, Mr. J. H. T. Turner, Mr. Boult, and Mr. Bromley Holmes, of the Liverpool Electric Supply Company, Limited, spoke. A cordial vote of thanks was afterwards passed to Mr. Yeaman.

Lighting the Fulham Town Hall.—A special meeting of the Fulham Vestry was held on Friday last to consider a recommendation of the Lighting Committee, "That the Vestry sanction the installation of electric light at the Town Hall at a cost not exceeding £2,000." Dr. Cooney moved the adoption of the report, but after doing so expressed a hope that the matter might be referred back to the committee for further consideration, as he did not think the time was yet ripe for undertaking this installation of the electric light, while, on the other hand, he wished members to have the subject well in their minds. Mr. Cornwall seconded the motion in an equally contradictory speech. Mr. Dyer said he could not understand what the previous speakers were driving at, but he would move as an amendment "that the question be referred back to the committee to report as to cost of installation, etc." He protested that they had no right to sink £2,000 of the ratepayers' money in a business that might not pay. Mr. Lawrence seconded the amendment. Mr. Cranfield said the discussion of the question was altogether premature, and he believed that £2,000 was far above the probable cost of the installation. They already had had a tender to do the work for £1,365, inclusive. Gas would spoil the decorations of the splendid new hall in twelve months, and he hoped that they might be able to have electric light from the first and keep the place clean. Electricity was safer and healthier than gas, and would cost 35 per cent. less. He did not think this subject should have been brought up at all without consulting him as the chairman of the Electric Lighting Committee. Mr. Weatherly said there seemed a consensus of opinion in favour of the electric light, but the expense seemed to make it impracticable. After some further discussion Mr. Dyer's amendment was put to the meeting and carried.

Public Lighting by Electricity.—By invitation of the Town Council, the Glasgow Philosophical Society held their ninth ordinary meeting in the Banqueting Hall, City Chambers, when Mr. Henry A. Mavor, member of the Institution of Electrical Engineers, delivered a lecture on "Public Lighting by Electricity." Prof. M'Kendrick presided, and there was a crowded attendance. The lecturer pointed out that electric light was now entering in this country on a new phase of existence, and public attention was constantly turning towards it with fresh interest. The establishment of distributing centres for electricity had produced a demand for electric current, which was altogether on a different scale from the demand for isolated installations, and electricians now thought as lightly of installations of 10, 20, or 30,000 lamps as they did a few years ago of installations of a few hundreds. The first scientific problem connected with the production and distribution of electricity having been solved, the next step was to attack the economic problem, so as to reduce its cost, and the natural tendency was to centralise the production so as to neutralise its cost. Mr. Mavor showed that the dynamo machine was the most mechanical article that had ever been produced. It gave out as much as 93 or 94 per cent. of the energy that was put into it, and, therefore, there was not very much to be hoped for in the way of cheapening the cost of production in this direction; but there was a great improvement possible, in fact already accomplished, in the incandescent lamp, so that it was not at all improbable that the cost of electric light would be less than half what it was at present within the next few years. In conclusion, the lecturer expressed the hope that in Glasgow before long electric conductors would lie down with the gaspipe, and that the light of a new era would spread its radiance over every quarter of the city. The lecture was illustrated by practical demonstrations and lantern views, and was greatly appreciated.

The Comstock Water Power.—Alvan D. Brock, writing in the *Overland Monthly*, thus describes one of the most remarkable instances of electrical transmission of power recently accomplished in the State of Nevada, on the world-famous Comstock Lode and the almost equally famous Sutro Tunnel. At the Nevada Mill there is a 10ft. Pelton water-wheel, which receives water through a pipe-line delivering water from the side of Mount Davidson under a head of 460ft., giving 200 h.p. Here the water is again caught up, delivered into two heavy iron pipes, and conducted down the vertical shaft and incline of the Chollar Mine to the Sutro Tunnel level, where it is again delivered to six Pelton water-wheels, this time running under a head of 1,680ft. Each of the six wheels is but 40in. in diameter, weighing 225lb.; but with a jet of water less than $\frac{5}{8}$in. in diameter, they develop 125 h.p. each. On the same shafts, which revolve 900 times a minute, are coupled six Brush dynamos, which generate the current for the electric motors that drive the stamps in the mill above ground. The result is that, where it formerly took 312 miners' inches of water to operate 35 stamps, but 72in. are now required to run 60 stamps. This is the most enormous head of water ever used by any wheel, and by itself constitutes an era in hydraulic engineering. A solid bar of iron thrown forcibly against this tremendous jet rebounds as though it had struck against a solid body instead of a mobile fluid. The speed of this jet, where it impinges against the buckets of the wheel, is two miles a minute—176ft. a second. There is another quality of these extraordinary wheels which renders them absolutely without a peer in the large family of prime movers. This is the immense power exerted per pound of weight. Those in the Chollar Mine, for instance, give out 1 h.p. for every 1·8lb. of weight. If there is anywhere a motor which begins to compare with them in this respect, the public have never been favoured with knowledge of it. And it seems there is no limit, outside of that which sets bounds to the head of water itself, to prevent further progress of the wheel in the same direction.

The Langhans Incandescent Lamp.—Mr. Langhans has during the last few months manufactured an improved lamp which may possibly be the beginning of an entirely new development in the manufacture of incandescent lamps. The main characteristic of this latest improvement in the Langhans lamp is that it requires a very low vacuum, corresponding to about one millimetre atmospheric pressure. So low a vacuum as this entirely obviates the use of the expensive and unhealthy mercury pump, as it can be produced by a mechanical vacuum pump specially constructed by Mr. Langhans for the purpose. In the new lamp the ordinary filaments of carbon have been replaced by those made of a metallic (silicium) conductor, and it is found that filaments of this description resist a temperature considerably higher than carbon filaments without being attacked by oxygen. This resistance to combustion, it is stated, is indeed so great that the silicium filaments will incandesce for several minutes in the open air without being destroyed. Notwithstanding the low vacuum the life of the silicium filament is equal to that of any of the best makes of carbon filaments, and it would almost be possible to do without a vacuum if it were not for the conductivity of atmospheric air, which would cause too great a loss of heat and thereby too great a consumption of current. This very nearly approaches incandescence in open air, but it is yet very doubtful if incandescence in open air is really a desideratum. The several processes employed in coating with silicium the Langhans metallic or mineral filament are simple and inexpensive, securing great regularity in the coating, as well as affording a high degree of certainty in the predetermination of the voltage. Ordinary carbon filaments coated with silicium by the Langhans patented process will also produce lamps consuming less current than lamps made entirely of carbon, and requiring but the same low vacuum as the silicium Langhans lamp. The silicium lamp consumes a current of only $2\frac{3}{4}$ watts per candle-power. We may add, that in all probability these lamps will be introduced into England very shortly, when electrical engineers will have an opportunity of judging of their merits.

High v. Low Tension at Paddington.—A special meeting of the Paddington Vestry was held last Friday at the Vestry Hall, Paddington-green, for the purpose of considering the question of the electric lighting in the parish, which had been considered by a committee of the Vestry. The question resolved itself into a discussion of high-tension against low-tension systems. Colonel H. C. Barchard proposed the adoption of the report, which recommended that the application of the Kensington and Knightsbridge Electric Lighting Company should be assented to. But if the Vestry considered the draft regulations now being prepared by the Board of Trade to do away with the objections to the high-pressure supply system, then the committee considered that the application of the Metropolitan Company might be considered. Both the Kensington and Knightsbridge Company and the Metropolitan Company object to the insertion of any clause reducing the time for purchase below 42 years. As the cost of lighting the streets with electricity at present would be in excess of gas, the committee did not feel justified in recommending it, though in the future, when the electric company's arrangements had been more matured, action could be taken for so doing with advantage. He observed that since the report had been drawn up the Metropolitan Company had varied its list of prices, and probably the other company would desire to vary its scale of prices, and he should propose that the company be communicated with, with that object in view. Colonel Blair spoke, strongly objecting to this. The Metropolitan Company was merely trying to gammon the Vestry, and he was in favour of the recommendation of the committee being adopted. Mr. Stephenson said he should second the proposition of Colonel Barchard. Mr. H. H. Mills proposed, as an amendment, that the provisional order be amended, inasmuch as the draft provisional order prepared by the committee did not secure to the ratepayers such advantages as they were entitled to receive as a consideration for the very valuable concession involved in the granting its assistance to a company to obtain an order for lighting the parish. Mr. T. S. Anderson seconded the amendment. Mr. Mark H. Judge opposed both the propositions before the Vestry. He did not consider the report a trustworthy document, and he was in favour of adjourning the matter. It was agreed to adjourn the further consideration of the matter.

Electric Lighting in the City.—On Tuesday a special meeting of the City Commission of Sewers was held at the Guildhall, Mr. Frank Green presiding. The Streets Committee reported that they had again had under consideration the draft of the proposed contract with the Brush Electrical Engineering Company, as returned by their solicitors, with various proposed alterations, and while deeming it necessary to resist certain of those alterations, they recommended the Court to concur in the following, namely: (1) That the company have way-leave in subways for private supply, notwithstanding the contract for public supply might have been determined. (2) That the private supply be exclusive for 21 years, whether the contract for public supply be determined or not. (3) That, as regarded the remedy of defects found on inspection, the penalty should not be enforced if the work of repair were commenced within 24 hours, and were proceeded with diligently to the satisfaction of the engineers. (4) That, as regarded the sliding scale, 7½ per cent. per annum on the capital sunk in the plant and machinery should be allowed for depreciation, and 5 per cent. of the profits available for dividend for a reserve fund until such fund should amount to a quarter of the paid-up capital. (5) That though the purchase of the undertaking for public supply at 21 years was under the Act, the purchase of the private supply at 21 years should be by agreement or arbitration; the purchase of either at 42 years to be under the terms of the Act. In the event of the Court's concurring in those recommendations, the committee asked authority also to conclude similar terms with the Laing, Wharton, and Down Construction Syndicate for another district. Mr. Cloudsley moved the adoption of the report. Mr. J. E. Sly proposed that it should be referred back for consideration, as he objected to the companies having the right to supply private consumers if their contract for the public lighting of the district had been terminated. The companies seemed to be imposing their own terms on the Court. Mr. Bowring thought it would be a public scandal to hand over the City, bound hand and foot, to private companies for 21 years. It would appear to be a premium to the companies tempting them to break the public lighting contract as soon as possible, having secured a monopoly of the private supply for so long a period. The chairman pointed out that the Act prevented them from giving an exclusive right to a company to supply the electric light within a given area, and the Commission were only contracting so far as they were able. Mr. C. T. Harris said that the proposed alterations were all adverse to the ratepayers, and should not be entertained. Mr. W. H Pannell, on the other hand, thought the Commission were making infinitely better terms than they would obtain under a provisional order. None of the alterations, in his opinion, was inimical to the ratepayers' interests. Mr. Deputy Scott and Mr. George Shaw also supported the report. The amendment was negatived by a considerable majority, and after some further discussion the report was adopted.

Brussels Tramways.—Those who know the conditions under which the electric tramcars were introduced into Brussels will not be surprised to hear that the electric service has been so far carried on at a loss. A few cars have been running among the horse cars and numerous trials and experiments have been made; these have certainly rendered considerable service to workers in the same field, but have not resulted in the most economical result. In the report submitted last week to the company's meeting, it is stated that the electric service has left a deficit o 28,616f. This figure forms the difference between the actual total cost of the electric traction and the calculated cost of horse traction during the period. The largeness of this sum is largely due to the frequency of the modifications inseparable to the period of experiment, and also to the fact that having only three cars while a larger number could have been run without much increasing the general cost, this has greatly swelled the relative cost of maintenance per car. The company have not entered into greater extensions both because of the necessity for large capital expenditure, and because the motor and gearing of the cars seemed to leave still something to be desired. The company have now had four years of experience, which they consider sufficient to make them conclude, whatever may be the progress in the accumulators or in the mechanical arrangements of the cars, that electric traction by accumulators is not practicable and remunerative under the given conditions of their line. It is beside the question, they think, that electric traction has had such great developments in other lands, and that it is substituted either by overhead conductor systems or by accumulators, the traction by horses in case where the latter are dear, or where the gradients, being small, do not present the difficulties of the Brussels lines, or where the difference between winter and summer services necessitates important changes in the stud; or where, in a word, special circumstances are encountered. But in Brussels the experience has shown them definitely that the most economical working of their line is by horse traction, therefore, from the 1st of May next horses will be reinstated on the Rue de la Loi line, and the electric installation will be utilised in some other way. From this report it will be seen that the resolve is definite to abandon the electric cars. It is certainly curious that the initiators of the storage car system in Europe should see fit to abandon their attempt exactly at the time when the great London tramway companies have been convinced of the financial success of the experiment, and are actively taking steps for the extensive introduction of the system The *Ingenieur-Conseil* of last week devotes considerable space to discussion of the report, and the present financial possibilities, and is exceedingly wroth, from an electrical engineering point of view, with reference to the affair. It alludes to the continued hostility which has existed since the commencement by the Brussels City Council against the innovation of the electric cars. It is for this real reason, it thinks, being in the minority in face of the wonderful development of electric traction in other countries, that they have locked up their power station; and it is practically certain that when in five years all the other tramway companies are using electricity they will be forced to reopen their station.

HOW TO PRODUCE ELECTRICAL PRESSURE.*

(Continued from page 149.)

Temperature of Coil.—The resistance of the conductor increases with rise in temperature. The resistance increases about ·002 for an increase of temperature of 1deg. F., so that to find the increase due to heating the increased resistance must be added to the normal resistance. For example, a wire that had a resistance of 1 ohm at the temperature measure 50deg. F. would have a resistance of 1 + (·002 × 50) = 1·1 at a temperature of 100deg. F. In the formula below where R is introduced it means the resistance at the temperature under discussion, and not the resistance at the ordinary temperature. The increase of temperature has also a detrimental effect upon the insulation, and if raised too high will soften, perhaps melt and set on fire. It is necessary then to so arrange the size of wire of the coils and the design of coil that as large a surface as possible, considering all other conditions, may be obtained for heat radiation and convection. This question is perhaps more important when considering the armature coils, but it may be discussed here. The heat generated in a conductor carrying a current is proportional to the product of the square of the current with the resistance

$$C^2 R$$

and the current being continued, expressing time by t this becomes

$$C^2 R\,t.$$

If the unit of heat taken is that raising 1lb. of water from 0deg. C. to 1deg. C. a current of C amperes through a resistance of R ohms produces per minute $0{\cdot}0315\ C^2R$ units of heat, or generally if H be the number of units in t minutes,

$$H = 0{\cdot}0315\ C^2 R\,t.$$

Knowing the heat developed it is easy to know the work performed since Joule gave us the mechanical equivalent of heat, which, for the unit adopted, is about 1,400 (1,389·8) foot-pounds. Hence

$$\begin{aligned}\text{Work} &= 1{,}400 \times 0{\cdot}0315\ C^2 R\,t\\ &= 44{\cdot}25\ C^2 R\,t.\end{aligned}$$

If all the work done in the circuit is used in producing heat

$$\text{Work} = 44{\cdot}25\ C\,E\,t.$$

for $\qquad C^2 R\,t = C\,C\,R\,t \text{ and } C\,R = E.$

This applies to all steady currents. In connection with work another unit called the WATT has been adopted.

The WATT (the unit of work) = volt × ampere (C × E) = 746 watts = one horse-power.

If in the last formula we require to know the work in horse-power we divide by 33,000, the unit of horse-power—viz., 33,000lb. raised 1 foot in 1 minute. Hence

$$\text{H.P.} = \frac{44{\cdot}25}{33{,}000}\,C\,E = \frac{C\,E}{746}.$$

Taking, then, that the electrical energy = C E or $C^2 R$ developed in any coils is expended in producing heat, then at the point when the temperature remains constant as much heat must be radiated or somehow conveyed away as is produced.

From formula given by Prof. Forbes, Mr. C. Hering states that a watt of energy will be dissipated for every 223 square inches of external surface of coil when the difference between the temperature of the coil and the surrounding air is 1deg. F. The Fahrenheit scale is that usually found in the thermometers used in England, though the centigrade scale is generally adopted for laboratory work. Putting this into a formula, we get

$$W \text{ or } C\,E = \frac{1}{223}\,T\,S = 0{\cdot}004476\ T\,S,$$

when W = watts lost in the coil, T = degrees Fahrenheit, and S = square inches. From this formula others of great interest can be deduced. Thus the greatest current that can be used in the magnetic coils of a *shunt* machine when the pressure, E, is known, so that they do not heat above a certain temperature, is found from

$$C = \frac{T\,S}{223\,E}.$$

Again, the greatest current for any allowable temperature above that of the air can easily be determined. Say, for example, 50deg. F.

$$C = \frac{50\,S}{223\,E} = {\cdot}224\,\frac{S}{E} \text{ or } C = \sqrt{{\cdot}224\,\frac{S}{R}}.$$

If 80deg. F. is the maximum difference of temperature, the formula becomes

$$C = {\cdot}36\,\frac{S}{E} \text{ or } C = {\cdot}60\sqrt{\frac{S}{R}}.$$

The formulæ can be used for *series* machines when C is known, for the original formula may be written W or C E or $C^2 R = \frac{1}{223}\,T\,S$, and this enables the greatest resistance which may be given to the coils to prevent overheating to be obtained—

$$R = \frac{T\,S}{223\,C^2}.$$

With a permissible rise of 50deg. F. and of 80deg. F. respectively we have

$$R = \frac{{\cdot}224\,S}{C^2} \text{ and } R = {\cdot}36\,\frac{S}{C^2}.$$

The surface of the coil in square inches may be

$$S = \frac{223.\,W}{T} = \frac{223\,C\,E}{T} = \frac{223\,C^2\,R}{T}$$

or the surface may be for a rise of 50deg. F. and 80deg. F. respectively.

$$S = \frac{223}{50}\,W = 4{\cdot}46\,W, \text{ and } S = \frac{223}{80}\,W = 2{\cdot}8\,W.$$

A large proportion of the wires for carrying currents will be laid underground, and in this case we have no data for discussion. The methods of laying and the kinds of insulation are so various, that only a long series of experiments will give an approximate solution to the question. A good insulator which is at the same time a good conductor of heat is a desideratum.

The amount of heating that takes place in different machines differs very considerably, the magnet coils of badly designed machines taking as much energy as 20 per cent. of the whole output, while in the best machines only 1·5 or 2 per cent. of the energy is required.

[These formulæ differ considerably from those of Mr. Esson as given in his paper lately under discussion at the Institution. ED. *E. E.*]

Armatures.—The armature of the machine plays a very important part in the economy of the dynamo, and just as there are numerous designs of field-magnets, so there are numerous designs of armatures. This book, dealing solely with elementary principles, cannot attempt to discuss the advantages claimed by one designer for his armature over that of others. There are certain broad principles which must be complied with, and there are certain interactions which must be known. It is these to which we direct attention. For this purpose we must refer again to the interactions between conductors carrying current, between magnetic fields, and between conductive and magnetic fields. Let A B, Fig. 24, represent a piece of wire in a circuit carrying current, and the rings represent the "loops of force," the arrows showing the direction of the current and the directive action to which the field or "loops of force" are due. Further, suppose this part of the circuit bent round on itself as in Fig. 25, we then see how the field around one bend of the circuit interacts upon the field around the other bend. The result of this inter-

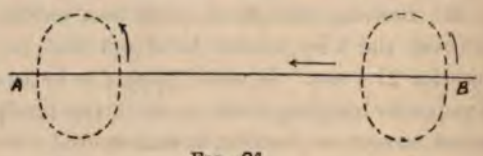

FIG. 24.

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* Extracts from "First Principles of Electrical Engineering."

action is a partial suppression or seeming partial suppression of the fields and a combination effect, causing a single field to encircle both wires, which may be represented in Fig. 26. This mutual action between the wires has the effect also of increasing the resistance of the circuit, thus it will be found that the resistance of a straight length of conductor appears less than the resistance of that same conductor made into a coil.

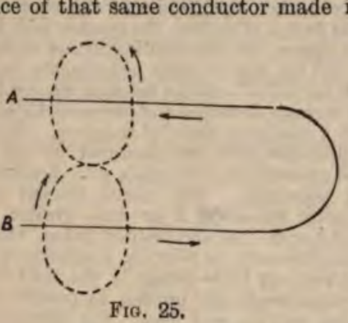

FIG. 25.

Usually the armature coils are not coils of single turns but coils of many turns, therefore this mutual action of the turns of the same coil has to be allowed for as well as the interactions between the separate coils.

It has been stated that the electrical pressure in a circuit under the influence of a magnetic field is due to, and is proportional to, the number of loops around the conductor forming the circuit Thus the electrical pressure in a circuit of which A B forms part would be proportional to the total number of magnetic loops, and the same holds good if instead of A B being straight it is coiled, though the electrical pressure in the latter case, if there are three coils say, will not cause three times the current in the former, because the resistance has been increased by the coiling. It would, however, be inconvenient, if not impossible, to distribute the loops of the magnetic field over long lengths of armature wire, and this little diminution of current owing to greater resistance of coil is easily allowed for in the design.

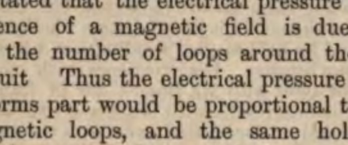

FIG. 26.

Consider now, shortly, the air space between the pole-pieces of the field-magnets. Where the space is vacant of everything except air, the magnetic resistance is the sum of the resistances of the field-magnets and the air space. It is clearly of importance to reduce the resistance of the air space as much as possible, and this can only be done by putting into, or bridging over the space, some material, such as iron, which has little magnetic resistance. Iron is therefore largely used, and this introduces other interactions. We have seen that a single or a multiple coil rotated between the field-magnet poles, has generated in it an electrical pressure varying from a minimum to a maximum; and the current due to this pressure is in the case discussed during one half rotation in one direction, and during the other half rotation in the opposite direction. The current, too, varies from a minimum to a maximum under the influence of the pressure. In many operations it is necessary to have the current in the external circuit to be continuous in one direction. Machines intended to produce such currents are called continuous-current machines, and require an apparatus called a commutator to direct the current always in the direction required. Machines which do not have the current commuted, but sent into the external circuit alternately in opposite directions, are called alternate-current machines.

(*To be continued.*)

ELECTRIC WELDING.

The importance of the use of electricity for welding purposes is gradually being acknowledged, and definite information is heartily welcomed. The American Government has enquired into the matter, and the following abstracts from the report of the commission appointed will show the result of the enquiry.

"To the Chief of the Bureau of Equipment and Recruiting, Navy Department, Washington, D.C.—In obedience to an order from the Honourable Secretary of the Navy, dated January 9, 1890, constituting us a board 'To examine into the process in use by the Thomson Electric Welding Company, of Boston, Mass., for welding metals, and to report as to its desirability and adaptability for naval purposes, and particularly for use on vessels of the Navy,' we have the honour to make the following report:

"The process of welding in use by the Thomson Electric Welding Company has been fully investigated by the Board, both experimentally, by tests made in our presence, and by investigation of the theories and principles involved.

"We find that at the present time this process renders it possible, practically, to weld wrought iron, cast iron, brass and copper rods, from the size of the smallest electrical conductors in use for distributing purposes to rods of 2½in. diameter, and to weld pipes, of larger sizes; to weld dissimilar metals and pieces of different formes of cross-section, to join by welding the ends of wire cables, and to form welded rings of small or large diameter.

"The operations necessary to accomplish these results were performed upon several different welders having holding clamps to suit the work in hand, and being of graduated capacity, each machine handling samples varying by a multiple of 10 in cross-section; and while none of them represent a machine for general use, it would be possible to construct one having removable clamps to suit different classes of work. In this way a small number of welders could be adapted to a wide range of service.

"We are convinced that the Thomson welding process can be found of great utility to the naval service, both on shore and afloat, for the following reasons: It can be used

"(*a*) In welding breaks in rods without altering them either in length or shape.
"(*b*) For welding tubes.
"(*c*) For welding angles and shapes of intricate form.
"(*d*) For welding copper, brass, cast iron or other metals.
"(*e*) For heating metals for forging, tempering, or upsetting.
"(*f*) For welding wire cables.

"Under these heads the following may be mentioned as a few of the many applications that would result on ship-board: For welding broken pump-piston rods, valve-stems, etc.; for joining wires of iron, copper, or other metals or bars of the same, of similar, or different shapes or sections; for making joints at angles with bars (T or Y joints) for mending chain and wire rope; for constructing or joining, end to end, pipe of all kinds, and of large or small diameter; working or joining lead pipe; welding T connections or elbows into lines of piping; welding safe ends to boiler-tubes; welding eye-rings, and welding these again to bolts or bars; repairing, cutting, and boring tools without hurting their temper; lengthening or shortening rods or bars; repairing broken cast-iron pieces of machinery, or broken cast-iron or cast-brass fittings; welding copper electric mains.

"This system of welding thus renders easy many operations in the working of metals which with the forge and smith have heretofore been considered impossible.

"It is the unanimous opinion of the Board that in the present day of ships constructed almost entirely of metals, and in which every fitting possible is made of metal, such a system as that which has been investigated by us becomes not only desirable, but a means to economy of expense, time, and labour, and would add to the efficiency of the vessel under any condition of service.

"This system of welding occupies a position of its own. It is able to do not only a large part of the work of the forge now in use, but is capable of doing much work that was hitherto considered impossible. By its use, the large accumulation of now almost worthless boiler tubes stored at the Navy yards could be made fit for service; and the quantity of spare tubes, and of many other stores now carried by ships, could be reduced.

"As the classes of work at naval stations and on ship-board differ materially, the welders designed for use in the two places should be constructed for the work that will be required of them; those for use on board ship being especially designed with a view to lightness, compactness, and adaptability to general work."

Abstract from report dated October 31, 1889, of the Naval Board, composed of Captain Henry Erben, Lieutenant A. Nazro, and Lieutenant Samuel Seabury, appointed by the Secretary of the Navy, to inspect certain locked-wire rope submitted for examination by Messrs. Cooper, Hewitt, and Co.: "A disadvantage exists in the use of the interlocked system in its inability to be readily spliced. Ropes can be tailed together or ends thoroughly secured for any purpose whatever, by using the sockets shown in Circular No. 2. These sockets containing a locking thimble, through which the end of the rope is rove, the end opened out and the wires turned back to the outside of the thimble, which is set up close against the inner face of the socket, molten metal being poured in to secure the necessary solidity.

"The rope can be welded electrically, and a number of specimens or such joints were shown the Board. The circumference of the rope is not increased by this method, and the rapidity with which it is done and the neat appearance of the finished job recommend it to the consideration of the bureau. The samples of electric welding had been subjected to bending, twisting, and tensile strains; and many of the ropes were broken, but in no case had the rupture occurred at the weld, the breaking apparently taking place where the temper is changed by the application of heat, some inch or so from the weld. The strength, however, at this point has been found to be from 95 per cent. to 97 per cent. of the full strength of the rope.

"The Trenton Iron Company are preparing machinery for making the welds in large ropes, but at present they only handle ropes up to ⅝in. The Board witnessed the welding of a number of specimens, and among them one of cast steel.'

INSTITUTION OF ELECTRICAL ENGINEERS.

JOINT DISCUSSION ON MR. SWINBURNE'S PAPER, "THE THEORY OF ARMATURE REACTION IN DYNAMOS AND MOTORS," AND ON MR. ESSON'S PAPER, "SOME POINTS IN DYNAMO AND MOTOR DESIGN." *(Authorised Abstract.)*

(Concluded from page 239.)

Mr. A. P. Trotter disagreed with Mr. Esson's statement on slip 2 as to the inutility of and the difficulties attending calculations of the stray field, and said that since Prof. Forbes gave his three Lemmas in 1886 the work has been comparatively simple, and constituted part of the drawing office routine at Halifax. Speaking of differences in the quality of iron, he said forged bars could be depended on, but charcoal iron was not so reliable. Any doubt as to the behaviour of iron, in his opinion, renders it all the more necessary to calculate the waste field, so that only one unknown factor may be present. This predetermination is most important when any departure from ordinary designs is made, for in such cases one cannot be guided by previous experiment. As an instance of the accuracy attainable in these calculations, he said that in Messrs. Goolden and Co.'s M type dynamo, where the leakage amounts to 60 per cent., Mr. Ravenshaw predicted this to within 1 per cent. Mr. Trotter also exhibited some interesting diagrams plotted by a novel method on the machine itself, which show the directions of the waste field under various conditions of armature and field excitation; on one of these the distorting effect of a large armature current could be easily seen. From such diagrams, combined with Prof. Forbes's formulæ, the speaker thinks a line can be determined, in terms of whose length the magnetic resistance between any two parts considered may be stated.

Mr. Vignoles confirmed Mr. Trotter's remarks about the calculations of waste field by Mr. Ravenshaw. He also pointed out that Mr. Esson used the word "saturation" in various senses, and he thought it desirable that a distinct meaning be given to the word by definition.

Mr. S. Joyce, speaking of Mr. Esson's rule for rise of temperature, said such rules could only give the temperature at the surface and not that of the interior, which was probably much greater. As the difference in temperature between the inside and outside of the winding varies as the square of the depth, this difference may become excessive in large machines. The expression for the difference on the assumption that the inside and outside surface are parallel planes was given as $\frac{h\ D^2}{2\,K}$ where h=C.G.S. heat units generated per cubic centimetre, D=depth of winding, and K its thermal conductivity. For cylindrical surfaces of ordinary dimensions the difference is about 3 per cent. less. The quantity K may be calculated from the equation $K=\frac{Z\ d}{2\,\delta}$, where Z is the thermal conductivity of the insulating material, d the diameter of the covered wire, and δ the radial depth of insulation. The speaker said the value of Z given for cotton by Prof. Everett was ·00001, by Prof. Forbes ·00003, but he himself found it 10 times the latter—viz., ·0003. His own experiments on "emissivity" of varnished cotton gave the number ·0005, whereas Macfarlane's result for blackened copper was ·0003. He had also found that by leaving about 10 per cent. of armature core exposed the difference of temperature between the inside and outside of the winding was reduced to a quarter that which exist when the whole surface is covered with wire.

Mr. J. D. F. Andrews said the specimens of armature winding exhibited by Mr. Crompton were very interesting, but thought the heating difficulty could be got over in a simpler way. In one dynamo he had constructed, with bars $\frac{5}{8}$in. × $\frac{3}{8}$in., the heating was immense when running at no load. On cutting away the pole-pieces tangential with the armature the rise of temperature was 100deg. F., and by putting the bars on edge this was reduced to 30deg. After rounding off the top corners of the bars there was no heating.

Mr. Stuart A. Russell, referring to Mr. Esson's curve for maximum output (Fig. 21), said he believed this was obtained on the assumption that the depth of winding inside the armature was equal to the depth outside. If the difference between these depths be taken into account, then in ordinary cylinder armatures, instead of the core being about four times the depth of the winding, it becomes five and a quarter times. As regards size and output, the speaker said he had found the rule, total induction ∝ (watts per revolution) $\frac{2}{3}$, very convenient, and that it nearly agreed with that given by Mr. Snell. Referring to the difficulty in compounding slow-speed machines, Mr. Russell said one cause arises from the want of proportionality between the additional ampere-turns on the magnets and the back ampere-turns on the armature. In the former they are proportional to the current simply, whilst in the latter they are proportional to the current multiplied by the angle of lead. Hence, if the compensating turns are made right for full load, then the middle of the curve will be too high. Concerning the design of motors, the speaker said he agreed with the authors of the papers, but the startling nature of the curves shown by Prof. Ayrton had led him to make experiments on the subject. In these a double horseshoe Gramme machine was used with the magnets, and armature currents decreased and increased 40 per cent. respectively so as to obtain a relatively powerful armature. In addition to taking volts and amperes the field was measured by the ballistic method. The first set of experiments were made with brushes of the ordinary thickness ($1\frac{1}{4}$ segments). The results showed that with no lead V − C R as a motor was about 8 per cent. greater than V + C R as a generator, whilst with lead and trail of 18deg. the difference was 4 per cent. This difference, he believes, is accounted for by self-induction, for there was very little change in the field induction. In the second set of experiments two brushes in parallel arranged so as to short-circuit four sections were used. The difference between V − C R and V + C R amounted to 75 per cent. of the mean, but it was also noticed that the change in the field only amounted to about 30 per cent., and that V − C R as a motor was greater than the E.M.F. corresponding to the induction used. From these observations Mr. Russell concludes that the E.M.F. of a motor may be made greater than that of a dynamo by short-circuiting a number of sections, thereby increasing the armature induction, but that no advantage is gained, because the result is just the same whether the greater induction is produced by field-magnet windings or by coils short-circuited by the armature brushes. His experience with motors having thick brushes did not agree with Mr. Snell's, for in tramcar work he (the speaker) got the best results with brushes of ordinary thickness.

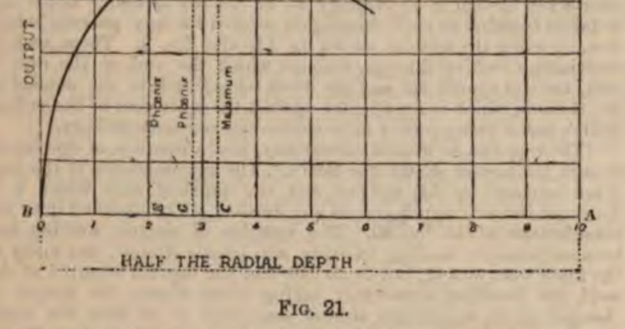

FIG. 21.

Mr. Wyles said no doubt need exist as to the possibility of making smooth commutator machines for high voltages, and that the difficulties experienced arose from the great differences in the insulation of similar machines. The insulation of some may be excellent, whereas that of others wound with equal care is comparatively bad. These differences are met with in machines of E.M.F.'s as low as 200 volts.

Mr. Geipel asked whether cross induction could not be reduced by cutting the pole-pieces in Fig. 3 of Mr. Swinburne's paper in two parts at E E, and by laminating the magnets in a direction perpendicular to that of the cross lines. Referring to Mr. Esson's temperature limit of 75deg. C., he enquired whether any modification would be made for machines intended for tropical climates.

Dr. S. P. Thompson, in a communication read by Mr. Kapp, said a good approximation to the back ampere-turns was got by multiplying the number of conductors between the pole corners by half the armature current, and that he agreed with Mr. Swinburne as to the usual position of the brushes. He complained of Mr. Swinburne's use of ergs in measuring magnetic potential, and asked why, in naming the pole corners, he had reversed the ordinary usage. He also enquired why Mr. Esson takes the load carried by armatures as proportional to the depth of armature core. Speaking of "leakage coefficients," he pointed out that this is not constant, even for machines of the same type, but is less for the larger machines. Referring to the statement by Mr. Esson that the induction in large armatures should be less than in small ones, Prof. Thompson asked whether this was true both of disc and wire cores. As regards smooth commutator machines for high volts he said Messrs. Paterson and Cooper had made such machines successfully for some time, and that in Ball's so-called "unipolar dynamo" was an instance of a smooth commutator machine working 80 arcs in series.

Mr. MacWhirter objected to Mr. Swinburne's use of the symbol Ω for magnetic potential, for this is the recognised symbol for megohm. He also said that some system of symbols was greatly needed, and suggested that the Nomenclature Committee, appointed by the society some five years ago, should present an interim report. Speaking of the magnetic pull on armatures of single-magnet machines, he said his firm found the method of placing the armature eccentrically very effective. Their motors were always made on the same lines as dynamos, for they found that machines with light fields always sparked.

The **President** expressed his great appreciation of both papers under discussion, but owing to the lateness of the hour would only criticise few points in Mr. Swinburne's. The rule given for lead of brushes seemed to him hardly correct, for in machines with which he was acquainted the lead was always less than half the angle between the pole corners. There were two points to which he wished to direct Mr. Swinburne's attention—viz., the effect of having a great or a smaller number of commutator bars, and of thick or thin brushes. Speaking of the term "magnetic resistance" he said there were two reasons why he did not use it. First, the generally accepted idea of resistance was such that $(\text{flux})^2$ × resistance was a rate of doing work, so-called "magnetic resistance" did not satisfy this condition. Secondly, "coefficients of resistance" are generally constants, and express properties of the material or medium. "Magnetic resistance," however, is by no means constant, and he thought its use open to the same objections as "resistance of an electric arc," an expression which was very misleading.

Mr. Swinburne, in reply, said the main subject of his paper had not been discussed. Its object was to show how to obtain an expression for the lead of the brushes in terms of the polar angle, and thus determine the back induction before the machine was made. This being of much greater importance in regard to large machines, the greater part of his paper referred to such machines, but unfortunately many of the speakers assumed it applicable to small machines, and discussed it accordingly. Prof. Ayrton, he said, had accused him of using "magnetic potential" where "difference of magnetic potential" was meant. This he denied, and pointed out that he had been careful to speak of differences of magnetic potential. Referring to "magnetic lag," he said the time lag discovered by Prof. Ewing had no connection with the once supposed lag to which the lead of the brushes was wrongly attributed. As regards the results of experiments on machines run as generators and motors by Prof. Ayrton, he pointed out that in those experiments where the E.M.F. became negative with a large armature current, the generator became a motor, and the brushes were then in the wrong position. He also contended that in all cases where the E.M.F. of a motor increased with increase of armature current, the brushes were not in the proper position. He believed Mr. Esson's results on the Bürgin machine was due to the same cause, for in this machine, unless made specially as a motor, the brushes could not be put back far enough to run sparklessly. Probably Mr. Esson had been misled by not being aware that the commutator connections are skewed. Replying to the criticisms on his use of "ergs" in measuring magnetic potential, he said Sir W. Thomson was the first to introduce it, and as it had been used by Maxwell and others he thought he might use it too. His objection to "magnetic resistance" are, first, that the term has no definite meaning; second, that the analogy whence it is derived is wrong; and third, if used it is liable to lead to error, as has already been the case with regard to transformers. Magnetism, he said, was analogous to electrostatics, and permeability to specific inductive capacity, not to conductivity, as the advocates of magnetic resistance would have us suppose. Referring to Mr. Kapp's remarks on enlarging dynamos to scale, he said that the impossibility of doing so successfully had been pointed out seven years ago, who about that time got three times the output at present obtained by Mr. Kapp and others from machines of the same weight. In his opinion four-pole drum machines would be used in the future for large outputs. Speaking of the Admiralty temperature test, Mr. Swinburne said it was comparatively useless, for it failed to pick out the test machines. To do this the temperature of the conductors should be ascertained, and this could be done by taking the resistance of the armature, in spite of Mr. Mordey's bad joints. He was sorry to learn that Mr. Mordey had not been able to make a shunt Brush machine work successfully, for he himself had done so, and the inventor of the machine approved of the arrangement. As regards the position of the brushes relative to the pole corners, he pointed out that Dr. Thompson's observations agreed with his own, and not with those of the President. In answer to the President's enquiry why he did not integrate to infinity on slip 5, he said the integration had only been given as a rough approximation near enough the truth to show that a comparatively weak field is required to reverse the current in the armature sections of direct-current machines. If alternating machines were under consideration the treatment of the integration would be much more important.

Mr. Esson, in his reply, said Mr. Kapp's method of overcoming side pull had the disadvantage of not allowing the coils to be slipped over the poles, and that even if adopted the distribution of the field was not the same near the top brushes as near the bottom ones; the arrangement in Fig. 9 gave a much more uniform field. He could not understand how Mr. Kapp saw any "dodge" in designing armatures to give large outputs, for the magnets were designed in accordance with the armatures with which they had to work. Neither could he understand Mr. Ravenshaw's remarks about the loading of armatures. In his opinion the machines of a set could not be all in the same condition as regards balance of field, and he thought all Mr. Ravenshaw's dynamos were underloaded. He was glad to see that Prof. Ayrton's remarks respecting the number of ampere-turns required for compounding agreed with his own statement on the subject. Speaking of the Admiralty test, he said the method of making the test was to heat the thermometer 30deg. F. above the surrounding air before applying it to the armature, and then noting its rate of rise or fall when so applied. Machines giving a rise of 40deg. were accepted, subject to a fine. He was now of opinion that the rise allowed by the Admiralty was quite enough for machines which had to work in hot engine-rooms. Referring to Mr. Crompton's armature conductors he said he had used stranded wire for the same purpose, but the section of his sub-divided conductor was round and not rectangular, as in Mr. Crompton's. He would have been glad to learn something about the collection of large currents, for this seemed to be one of the most difficult problems at present. On the subject of motor construction Mr. Esson said Prof. Ayrton's curves showed that it was difficult to prove either point conclusively. However, he thought he could see where Profs. Ayrton and Perry had been led into error. In their paper on electromotors, etc., the output of a machine is given as $W \propto (L l \cos \alpha \mp l^2 \sin \alpha)$, where L and l are the weights of the magnets and armature respectively, and α the angle of lead. In order that this may be a maximum for a dynamo (where the negative sign is to be taken), L must be large compared with l, but in dealing with motors the professors said the + sign should be used, and this led to the large armature view. Mr. Esson, however, contended that the negative sign is the one to be taken both for dynamos and motors. The positive sign, he said, leads to bad machines, which always spark.

PHYSICAL SOCIETY.—March 21.

Prof. W. E. Ayrton, F.R.S., President in the chair.

Mr. A. E. Childs was elected a member of the society.

The following communications were read :

"**The Villari Critical Points in Nickel and Iron.**" By Herbert Tomlinson, F.R.S. Villari has shown that the permeability of iron is increased by longitudinal traction, provided the magnetising force does not exceed a certain limit, but beyond this limit traction produces a decrease of permeability. The value of the force for which traction produces no change in the permeability is known as the Villari critical point. As far as the author is aware, no previous observer has found a similar critical point for nickel; but by confining his attention to *temporary* magnetisation he has detected such a point with comparative ease. He has also examined the variation of the Villari critical points in iron and nickel with change of load, and has investigated the influence of permanent strain on these points. The experiments were made by the ballistic method, using wires about 400 diameters long. In each set of observations the permeability was obtained with various loads, the magnetising force being kept the same, and with each load the circuit was closed and opened until the swings on make and break were equal; this swing was taken as a measure of the induction under the given load. Several diagrams accompany the paper, in which load and percentage change of permeability are plotted, regard being had to sign. The author finds that for annealed unstrained iron the critical value of the force decreases as the load increases, and that the Villari point is much lower for temporary than for total magnetisation. With a load of 4·7 kilos on a 1mm. wire the value of the force giving the temporary point was 2·8 C.G.S. units. He also found that for a given magnetising force there are generally two loads, which have no effect on the temporary magnetisation. With unstrained nickel the critical value of the force is much greater than in iron, being about 114 C.G.S. units for a load of 10 kilos on a wire 0·8mm. diameter and 67 for a load of 6·6 kilos. For a force of 21 units no critical point exists. Experiments on a permanently strained iron wire show that for magnetising forces ranging from 0·03 to 0·3 there is no critical point, and all the resulting curves are identical. There is, however, considerable difference in the observations taken during loading and those taken on unloading. For greater magnetising forces the curves cease to be identical, and the maximum increase of permeability becomes less and less until for a certain force the curves begin to cut the load line. As the force increases beyond this value the point of cutting approaches the origin, and the curves begin to cut the load line in two points. Further increase of force to three C.G.S. units causes the first point to disappear and the second point recedes from the origin. Finally, with sufficiently high magnetising forces the second point cannot be reached before the wire breaks, and the curve lies entirely below the load-line. With nickel, the curves for very minute forces—like those of iron—are exactly the same for different values of the force, but they lie below the load-line—*i.e.*, the permeability is diminished by loading; there is no difference, however, in the loading and unloading curves. Beyond a certain value of the force the identity of the curves ceases, and that part of the curve near the origin bulges towards the load-line. For a force a little over 21 C.G.S. units the permeability begins to increase with load, and the curve cuts the line in one point, which point recedes from the origin as the force increases.

Mr. Shelford Bidwell said that Prof. J. J. Thomson, reasoning from the change of length by magnetisation, had predicted a Villari point in cobalt when compressed, and this was verified experimentally. On applying similar reasoning to nickel, he (the speaker) did not expect to find a Villari point, and both Sir W. Thomson and Prof. Ewing had searched in vain for one. In some experiments, not yet completed, he had examined the behaviour of nickel, both loaded and unloaded, when subjected to various magnetising forces. These show that the metal always contracts when magnetised. For no load the contraction at first increases with the magnetising force, but attains a maximum. With a moderate load the contraction is less for small forces, but for larger forces becomes equal, and then exceeds the contraction of the unloaded wire. For greater loads the contraction is less than when unloaded for all values of the force.

"**On the Shape of Movable Coils used in Electrical Measuring Instruments.**" By Mr. T. Mather. The object of this note is to determine the best shape of the horizontal section of swinging coils, such as are used in D'Arsonval galvanometers, electro-dynamometers, wattmeters, etc. Assuming constant period and constant moment of inertia about the axis of rotation, it is shown that for zero instruments, the best shape of the section is two circles tangential to the direction of the deflecting field at the point about which the coil turns. A table accompanies the paper, in which various forms of section are given, together with their relative deflecting moments per unit moment of inertia, the coils being taken of equal lengths, and the current density constant. From this table it appears that ordinary D'Arsonval coils only give about 45 per cent. of the maximum deflecting moment, and ordinary Siemens dynamometers from 40 to 53 per cent. The various assumptions made in the paper are shown to be justifiable in commercial instruments, and the modifications necessary in special cases are pointed out.

Mr. C. V. Boys said he had, when working at his radio-micrometer, arrived at a shape similar to that recommended in the paper. He also noticed a peculiar relation true for all shapes where the length parallel to the axis of rotation is great compared with the breadth. Suppose a coil of any dimensions, then another coil of half the breadth and double the length and cross-section will be dynamically, electrically, and magnetically the same as the original. For the moment of inertia the electric resistance and the enclosed magnetic field are equal. The above relation is also true when the breadth is not small if the cross-pieces be thickened near the axis so as to make their moment of inertia proportional to their length. He enquired whether the author had considered the subject of grading movable coils. He himself was of opinion that, unlike fixed galvanometer coils, the wire near the axis should be thicker than that further away.

The **President** remarked that in 1881 Prof. Perry and himself exhibited a wattmeter at the Society of Arts whose movable coil somewhat resembled one of those in the paper, which gave a deflecting moment of 95 per cent. of the maximum. In designing the instrument they had felt that the ordinary method of using a comparatively large swinging coil was not the best, and this led them to the shape adopted

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LOCAL AUTHORITIES v. SUPPLY COMPANIES.

It is rumoured that the Board of Trade model provisional order will contain a clause to enable local authorities to transfer their orders without reference. This clause has been inserted at the instance of the municipal authorities, who, by means of a deputation, impressed their views at the Board of Trade. The question of the influence of such a clause as this upon the industry has been brought before the Electrical Section of the London Chamber of Commerce, and though we hardly know how far the section cares for its transactions to be reported, we think there can be no difference of opinion as to the desirability of discussing such a question in a larger field, especially as the clause referred to is held to bear very hardly upon supply companies. Supply companies are like extreme politicians—a necessity, often pursuing their object, if not wisely, with a great amount of energy, a property of the utmost importance in the early years of any industry. The case of the supply companies is a simple one, and easily understood. They imagine that many local authorities will proceed to obtain provisional orders for the direct purpose of getting a stumbling block in front of the real workers. It is contended that they do not intend to carry out the work themselves, and in some cases, if they obtain provisional orders, they intend to hand over, or, to use the usual terminology, to transfer their rights to a bogus company consisting of seven persons, who will not move a step. It is thought that the gas interests are sufficiently powerful in many places to get the orders transferred into the hands of those who are bound up in that interest.

Experiences differ in regard to municipal authorities. An influential section of the electrical industry strongly holds the opinions we have just expressed. On the contrary, we, and perhaps a few others, hold the directly opposite opinion. Of course we ought not to know anything about local authorities, but by a peculiar connection outside electrical work we happen to be very closely concerned in local work, and in direct touch with the local authorities. Hence the opinions expressed are by no means hearsay, or evolved without reasons, and thus may once more be stated—that the majority of the local bodies moving in electric light matters are moving with the intention of doing work and not with the intention of blocking the way. There will always be a few cases where interested parties are able to pull the ropes to favour gas interests, but the percentage is small. We quite understand, nay, we know, that in some instances the local authorities are moving because they will not be handed over to the tender mercies of supply companies. They take up the position to parody Wordsworth's little girl,

"I do not like thee, Dr. Fell,
The reason why, I cannot tell;
I do not like thee, Dr. Fell."

When it can be proved that the municipal authorities are the antagonists of the light and not of the company, we shall change our policy and support the exploiter against the local authority.

If the action of municipal authorities in getting the insertion of the clause referred to is indeed caused by a desire to hinder progress, then the sooner the clause is got rid of the better, but we cannot accept this interpretation of their action. Further, when corporations are the owners of the gas supply they have not shown themselves opposed to the introduction of the electric light—Bradford, to wit. Where the corporations are not the owners of gas works, and where, in many instances, they would like to be owners, it might be surmised they would rather tend towards the introduction of the electric light under their own auspices in order to save the rates.

The tendency of men's minds is either towards the introduction of electricity, or against it. If the general idea be that it must come, no matter what the idea of the moment is about its crudity or its perfection, the great number of local authorities will certainly not hinder but rather tempt its introduction. Those who rail against the action of local authorities forget that the local authority has more claim for consideration in its own home than foreign company promoters. If supply companies imagine for a moment that they are going to succeed in any antagonism they may think fit to show against the local bodies, the sooner that idea is dissipated the better. It will be far more to the advantage of the industry that development should take place under conditions that will render the progress permanent, rather than that a lot of small companies should be promoted, with insufficient capital to enable them to cope with the general lighting of a district or a town. Most local authorities can get all the money they require at a less cost and in an easier manner than even a local company backed by a supply company. Let anyone who can be impartial watch carefully the history of most of the troubles arising between companies and authorities, and they will find that, like Kilkenny cats, the companies have been springing at one another's throats, and that the local authority has stepped in so that a little peace and quietness might be obtained. Here and there a case of extreme hardness towards a company may be cited. A large amount of good work may have been done, the local people stirred up, a pitch of enthusiasm reached which promised to carry the company to success, when a rival or the local authority steps in, and the whole work is lost to the company. Such cases we deplore, but we do not see how they will be avoided by the industry setting itself against the local authority.

There must be a give and take upon both sides, and the best interests of the industry will be served by flexible rather than by stringent regulations. A supply company endeavouring to get the introduction of the light into a town is very much in the same position as any other firm trying to obtain business. Only a small percentage of the enquiries lead to actual business, and although time and money may be spent upon the attempt to get an order, it is always understood that a competitor may and often does slip in and reap the benefit. No doubt hard words are sometimes used, especially in very flagrant cases, when information has been obtained for the purpose of priming one competitor against another.

Taking, then, that something may be said on both sides, we incline strongly to the opinion that direct opposition, either from the industry collectively or from the supply companies collectively, to the local authorities will lead to no good result, and unless the trouble to be apprehended is likely to be general, such opposition should be persistently condemned.

DAMAGES.

The result of the case referred to in another column is that a jury has awarded £800 compensation for the death of Thomas Hill Garman, through an accidental touching of one of the Brighton and Hove Electric Light Company's wires. Although we have from time to time had to report accidents from America, this is perhaps the only one that has become prominent in this country through litigation. The report shows that there was really no defence, it being admitted that the wire was negligently hung; in fact, from reading the account of the accident, it is difficult to come to any other conclusion. No wire should have been in such a position that it could have been accidentally touched by a man pursuing his ordinary work. We trust that this will be a warning to all electrical engineers to be careful in designing the run of overhead wires.

THE REIGNIER-BARY DYNAMO.

At the last meeting of the Société Internationale des Electriciens at Paris, an interesting paper was read upon the new dynamo designed by MM. Reignier and Bary. This machine is distinguished by the construction of the armature, in which the copper wire ordinarily used is replaced by strips in sets of three, one strip of copper between two of iron, with insulation between the couples. An armature of small dimensions is thus furnished with a relatively large amount of active wire, and a machine of great specific energy is obtained. No further details are yet given, but the following are the figures given by M. Reignier. The experimental machine of 10,500 watts (70 volts and 150 amperes), weighs 260 kilog. (572lb.). This gives 40 watts per kilog. (18·2 watts per lb.) of the total weight. The armature has a peripheral speed of 10 metres (33ft.) per second at 1,800 revolutions per minute. The electrical efficiency is 94 per cent., and the commercial efficiency 90 per cent. To properly understand the importance of the improvement obtained from the point of view of watts per kilogramme, the following table is given from some of the best-known types:

	Edison.	Des-roziers.	Rech-niewski.	Reignier-Bary.
Watts per kg. of dynamo	9	21	21·5	40
Watts per kg. of copper in armature............	500	(?)	800	1,800
Watts per kg. of copper, total.....................	92	250	270	445

A further description of the Reignier-Bary dynamo is promised.

SAFETY AND SAFETY DEVICES IN ELECTRIC INSTALLATIONS.*

BY PROF. ELIHU THOMSON.

(Concluded from page 236.)

Another thing to be avoided in extended systems of multiple arc work is grounding or leakage to ground of current over resisting surfaces or materials. The tube system is useful here as well, and the placing of two wires at difference of potential near together assists somewhat, but does not entirely remove liability of grounding. Testing for grounds in the system, taken in sections, is the proper procedure, although this does not provide against all suddenly formed leaks. It may be argued that in this case two grounds are necessary to cause a leak, one on each side of the system, and this is true, but in very extended systems of overhead work more or less general leak exists, which may provide sufficient current to feed, as it were, a local leak to ground from either main.

Let us now deal with what is called the alternating or induction system of supply, in which the local or house mains are separate from the primary mains, and of much lower potential. For lighting purposes the system is very flexible, and enables distance to be overcome. The secondary circuit is, or should be, entirely out of connection with the primary mains of high potential, and the potential differences of the secondary circuit may be so low as to be incapable of giving a severe shock under the conditions of use, and to be almost incapable of setting on fire on account of the absence of arc-forming tendencies. This is, indeed, an important factor in alternating-current work, and conduces to the perfect working of switches and cut-outs, and the prevention of diversion to ground. Good work is all that is needed in this case to abolish all risk if we leave out the main high-potential current. The local line is unaffected by leaks or grounds at other parts of the system, and is, therefore, in this respect in a better condition than is found with the consumer's lines in any direct system of supply. On the other hand, all the cases in which persons have received a shock from an alternating current of 1,000 volts or upward without being killed are fortunate accidents, for there cannot be the slightest doubt that such current can and will kill under conditions favourable to its passage through the body. There are many cases of severe shocks having been obtained from such currents without permanent injury. On the other hand, there is a sufficient number of fatalities on record to sustain the position taken. The risks with higher than 1,000 volts alternating current are, of course, greater. It must not be forgotten in this connection, that the actual potential differences in an alternating current of 1,000 volts are higher than that figure, and may be, at every wave, upward of twice as much. This confers on such currents an actual and measurable striking distance between the two mains. As with arc lighting lines, the main or primary wires, if overhead, require to be kept thoroughly insulated and free from leaks to ground. The covering for the wire should be capable of resisting moisture, and the wire used be strong enough to prevent any possible breakage. If the primary wires break and come down they are still kept charged from the dynamo, which is not always the case with arc light lines. If, however, the insulation is strong and perfectly good, the risk to life is small in such case. There is one fact I wish to impress, however, and it is that with a perfectly-insulated set of alternating primary mains feeding transformers there still remains the static capacity of the line or cables and transformers, and this may be of an amount sufficient, if a person is grounded and touching the primary line, uninsulated, to give a severe, if not a fatal, shock. This inductive shock or discharge is, of course, far more pronounced with ordinary underground conductors than with aerial lines, and increases with the size and number of transformers and the extent of the line. It also increases as the voltage of the primary line is increased. Hence, it is quite important that no leak or connection exist between the primary line and a secondary in such system, or otherwise there may be a transfer of potentials of the primary line to the secondary, so as to involve risk of shock to the consumer, or risk of fire from leaks to ground indoors. It will not do to say that such connections do not often form, for they may form from defects in construction, from moisture, and particularly from lightning discharges. A person standing on a damp floor, leaning on a steam radiator, touching a gas-pipe grounded, or in other ways, may, if he handles or touches the secondary line at any part of it, be in peril of severe if not fatal shock. What was without this condition a most harmless local line, becomes most dangerous.

The writer early recognised this danger, and felt that, unless it was provided for, the induction system was not advisable for general use. As a consequence, the expedients of grounding the secondary, or of surrounding the secondary by a grounded sheath, or of cutting off absolutely by automatic means the local line when connected with the main line, or of automatic grounding of the secondary by insulating films or spaces which are punctured or overcome by the potential of the primary when connected with the secondary, were devised as safety devices. The grounding of the secondary is the most simple and effective if good grounds be made. It must, however, be done with certain precautions to ensure the best results.

The second expedient of a grounded metallic sheath between the primary and secondary is persistently called "Kent's sheath" when alluded to by our English cousins, despite the fact that it is American in its origin. It is effective as a protector, as it carries to ground any discharge leaving the primary before it reaches the secondary. The sheath is easily made by placing a somewhat open wrapping around either the primary coil or the secondary coil of the transformer made of flat metallic ribbon or insulated wire, the ends of which are grounded when in use. The course taken by the wrapping is around the wire of the coils at right angles to its direction of winding. The automatic absolute cutting off of the connection between the transformer coils is also effective, and has undergone several modifications in other hands. The last protective device mentioned above leaves the secondary insulated from the ground until a contact or leak from the primary takes place, when an automatic ground is made. One of the forms consists in the interposition between the ground and the secondary coil or line of a film cut-off, or thin paper film between two metal buttons pressed together, one button connected with the ground, the other with the transformer secondary. This device is very effective in securing a safety ground connection of the secondary when the primary leaks to it. A well-constructed transformer properly installed will not, except by accident, lose its insulation between primary and secondary, and such insulation should always be many times that otherwise requisite, so as to have a margin of safety, but the safety device is none the less a necessity in its use.

I consider that a properly arranged double wire cable, well insulated, constituting the primary line, laid in ventilated pipes underground, transformers connected therewith, also enclosed in a grounded metal case, as in the cellar of a building, a secondary line of low potential grounded, or provided with safety devices as mentioned, embodies as safe a system of incandescent electric light distribution as can be devised, both as to risk to life and danger of fire. It ensures complete safety to all the consumers, and to each one individually. It enables long distance work to be undertaken, and allows low voltage lamps to be used with their increased economy. The risks are confined to the electric station and the primary lines, which should be handled by men who know their business. The non-commutation of the current at the generators is another advantage of course. The disturbing influences, which in the best organised plant may be introduced by lightning, are serious and sometimes destructive. It is not that the lines are struck by lightning in causing such trouble, but the mere inductive current or discharge from a flash of lightning is quite sufficient. It puts upon the line potentials of many thousands of volts, and tends to break down insulation everywhere. Lightning arresters are therefore important safety devices in more senses than one. They save the machines in the station and the apparatus outside. In the alternating system they save from puncture the insulation between primary and secondary coils of transformers and between the turns of the primary coil itself. Every plant, then, should, if subject to lightning induction, be provided with efficient lightning arresters or dischargers.

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* Paper read before the National Electric Light Convention at Kansas City.

A discussion of this general subject, however brief and necessarily restricted in scope, would be very incomplete without allusion to the subject of contact with telephone or telegraph wires by electric light conductors. Underground and in conduits such contacts could not easily occur, though leak might readily take place between lightning-conductors and other wires. In any case, there is a risk of such wires carrying current into buildings or to positions bringing about shocks to persons, thus involving risk of fire or danger to life, or both. As a consequence, a set of safety devices has been brought out under various names whose purpose is to cut off dangerous currents when they reach or traverse lines, such as those of the telephone or telegraph. It is my opinion that in cities the provision of approved devices of this kind should be compulsory. Most of those which I have seen are not well enough designed or made to be perfectly relied upon, but are much better than nothing and may possibly suffice. Such apparatus, however, should be made so as to be perfectly reliable and undergo a regular inspection. Mere fuses, even if made long, are not enough. There should be placed in every circuit liable to contact with lighting or such like conductors, and at a place in the circuit where it enters a building, a protective device which, to be complete, should shunt or absolutely cut off the section of wire indoors, or ground the same in case of abnormal current on the wire, or abnormal potential.

There is much more to be said on this subject, and I am conscious of only having touched upon certain important matters in this paper. If I have succeeded in pointing the way to better conditions in any case I shall be more than satisfied.

To sum up briefly, safety in outside work means care in placing, maintaining, and insulating conductors, whether used overhead or below ground. This means the employment of only good linemen, and not men who are ready to incur risks through a reckless disregard of conditions of failure to comprehend their importance. Men who have done telephone or telegraph line work are not necessarily prepared to undertake electric light and such other work with the best success. Safety in inside work means, primarily if admissible, separation of the inside circuit absolutely from the general supply mains, and in any case it means that good, careful workmanship is requisite, and that the employment of safety devices, amply sufficient to do the work required of them in case of accident, is imperative.

Safety from current entering buildings upon telephone, telegraph and other wires, means first, a more systematic placing of such lines apart from electric mains, whether above ground or below, guard wires and insulated wire for such lines, stronger wire, especially for telephones, and the employment of safety devices in case of accidental leaks or crosses occurring with electric mains, of either low or high potentials, and a periodical inspection by proper officers.

PRODIGALITY IN ECONOMY.*

BY C. C. HASKINS.

The cautious man of business, when the dull season comes round, goes carefully over his past record, scans his methods, weighs his successes and failures, and endeavours to arrange his future so as to increase the former, and to the greatest possible extent diminish the latter. If he finds that by a liberal expenditure of energy or money in some particular direction he has made satisfactory advance, he seriously considers whether more extended effort in that direction will not still further aid in the general result for which he is striving, and he as carefully passes by and ignores those plans and efforts which have proved either disastrous or very moderately successful.

There are times and occasions when such retrospective examinations of methods and systems are demanded by circumstances, and—as in religion and politics—a revival seems to be required to bring the record of the past up to the programme of the future, that the one may be used for the improvement of the other by direct comparison. In such a connection, I have thought that possible good might result from canvassing the question, whether there has not been in the past, whether there is not now, among the electrical fraternity, an inclination to practise a sort of delusive economy in many directions, a policy which, to use an old and homely proverb, is "penny wise and pound foolish."

A few years ago, when the arc light was hardly more than a possibility, the fraternity, composed wholly of those whose electrical education had been acquired while handling nothing heavier than a quadruplex telegraph battery, brought such knowledge as then existed to the work. One line that I call to mind was put up with dry cotton-covered wire—magnet wire—and the terminals of the line were carried to ground through the gas and water pipes. It was a commendable job, for the best was done with the knowledge at hand. Truth to tell, it would not have been a very dangerous affair if it had got away entirely, for it was a very small plant, and, like many another nursling, quite feeble. It was not long until the owner demanded an improved circuit, and again the best wire in the market was used. A second time the plant was overhauled, and the second wire was not considered good enough, but was substituted by one of the best rubber wires known to the trade. I should add, that in each instance the plant on being overhauled was increased in size as well as improved in construction.

I once asked the owner of the property if the alterations and improvements in the plant were not very expensive. His answer showed me true economy in coal bills, wear and tear of engine and boiler, increased immunity from danger to person and property, and a better, both brighter and steadier light at less cost, with less rebate bills, and less unpleasant interviews with his patrons.

I have in mind a second plant, where it was deemed wise by the management to purchase everything which could aid in tabulating expenditures, in the more readily handling the work to be done in the dynamo-room, in the engine and boiler rooms, and in the office. No inconsiderable amount of money has been expended in the purchasing of instruments for procuring the various data. Every pound of coal and every bushel of ashes is weighed, and the results are as carefully kept and as faithfully exact as those of a bank bookkeeper's balance-sheet. The performances of the engines and dynamos are duly recorded for every day's run. The lines are measured, not only for insulation, but for copper resistance as well, and a record to the minutest particular is made up daily for the eye of the manager. The most minute leak is thus discovered in time to prevent a great waste, and is repaired before sunset if possible, so that no greater strain is set up when the dynamo is again set in motion. Since the first revolution of that engine there have been paid in repairs—renewals of parts damaged by electricity—less, during over 12 months' constant running, than on many a plant of one-quarter the capacity is wasted in the item of oil alone.

A plant not unlike the one last mentioned, one in which all these vital matters are recorded daily, and tabulated for the manager's eye, has been cited to me as an example of what may be accomplished by a study of such information. In this plant there are 14 dynamos in daily use, consuming an average of 1,900lb. of coal per day. The record shows that of this there is about 15 per cent. waste. The manager shows that he is using 4½lb. of coal per horse-power an hour. And for the engines, shafting, dynamos, etc., one barrel of oil is consumed per month. I would gladly mention names in these cases were it not that my lips have been sealed by parties furnishing the information.

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* Paper read before the Convention of the National Electric Light Association at Kansas City.

Oils for lubrication are as plentiful as blackberries, and 12 cents, 15 cents, 20 cents per gallon has a fascination for for him who searches for bargains in oil. An apt illustration of the economy of cheap oil was lately given in a railway publication. According to the writer, on an Ohio road, the newly-appointed superintendent of motive power learned that the valve oil in use, costing 32 cents per gallon, was giving an average run of 100 miles per quart. He found, also, that an average of one valve seat per day was being faced at the shop. He ordered an oil used that cost 50 cents per gallon, which gives an average of 200 miles run per quart, with only five valve seats to face in four months. Fifteen valve seats to face in a year, as compared with 365, and half as much oil to do the work of the cheaper lubricant. In other words, 25 cents. against 32.

Another case comes more directly in our line. Oils costing 12 to 15 cents were found to answer well enough in an engine and dynamo room, so far as heating was concerned, but no pains were taken to look beyond that effect, until, after a time, it was discovered that the journals had a silvery white, instead of the polished, mirror-like appearance they should present. Calipering the shaft showed that with the cheap oil the shaft had worn away more in three months than it should have done with a proper lubricant in as many years.

The time wasted in chaffing and canvassing for a bargain in cheaper oils might be more economically used by the purchasing agent in athletic development, to the end that oil fiends and other greasy tramps might better comprehend the words "no admittance," which should ornament the door of every dynamo-room. Present company is, of course, always excepted.

As it is true that no man knows more than the rest of the world, so it is true that no man can do all that is to be done in the various departments of a central plant. But human nature is weak, and the range of human eyesight is limited. It is not by any means seldom that the principal official of the plant endeavours to transact his business from the table of his roll-top desk, without ever getting his legs from under it to see personally how matters are progressing. Jones calls and arranges to have half a dozen lights put in his store. The manager orders the superintendent to have it done. The superintendent passes the order to the foreman of construction—from thence it goes to the foreman of a gang, and he gives the order to a couple of his "Indians" to do the work. From the manager down to the foreman of the gang, inclusive, no one knows anything more about that installation than the King of the Sandwich Islands. If it goes all right, nothing is ever heard of it, but if a fire occurs, or some person is injured, the whole fraternity, the electrical light and power service of the entire world, has received a black eye which requires months to heal. What is everybody's business in this case should be the business of an inspector.

Different methods of managing plants are illustrated by a couple of centrals not very far from Kansas City. They represent extremes. In one of these there is a general impression that someone had done it himself. The dynamo is in a building which seems rather to have grown under adverse circumstances than to have been constructed intentionally. It stands on posts, the space between these boarded up from the ground to the sills. It has all the advantages to be derived from ventilation, and it is well up from the ground. In one portion of the room stands the engine and boiler, threatening destruction to the establishment by either shaking it down or blowing it up—if one may judge by the second-hand appearance of everything. The line is in excellent keeping with the rest. My informant says the wire lies on roofs and against buildings, and is a constant menace to person and property. Connectors in place of soldered twist joints are so constant as to give the idea of the company's having secured a great bargain by purchasing all some concern had, and the consequence is that the lights are unsteady, weak and blear-eyed, while the dynamo has assumed a sad, unhappy cast of countenance, such as one sometimes meets the day after Christmas. The reason for all this unhappy condition of affairs is found in a false economy; the employment of incompetent engine and dynamo men and other cheap ignorance. The result may be foreseen—the plant for sale.

But a short distance away from this disgrace to the fraternity and the art there is a successful plant run, as it were, by a one man power. There are over 100 arc lights, and one of two persons sees individually everyone of these each day. The parties are father and son. The dynamos are as thoroughly cleaned as possible every 24 hours, and there are no corners for the accumulation of dirt that are not carefully looked to. There is no greasy sawdust under foot, no oiled rags stowed away for spontaneous kindling material. Everything is kept snug, clean and in order throughout the entire plant, and the total amount of repair expenses for one year was merely nominal. This plant is not on the market.

These are no fancy sketches. They are taken from life. I fear the first-named case has no representative here. It would be well, perhaps, if it had.

A case of false economy I copy from the *Electrical World* of December 14 last. In this instance an electrical engineer, compelled by a railway accident to remain over night in a small town, visited the lighting station to kill time, and found a mere lad in charge, who told him the plant had not turned out as profitable as was expected, and the stockholders were growling about the prospects. Inspection of the circuits showed that while they were in excellent order, with the exception of a loosened connection or two, the lights were not giving out their normal brilliancy. Returning to the station he located the trouble in the boiler-room, where he found the grate bars covered with a mass of hardened clinkers, through which but little air could circulate, and which required the most severe exertion to remove, while further examination showed that neither the flues nor the tubes had been properly cleaned for months. All this was remedied the following day, with the result of plenty of steam, good light, and a saving of about one-third the fuel. The writer goes on to say that even this pointed and striking lesson in economy was lost on the directors. The boy was retained and permitted to go right on running the plant in his own feeble way.

In construction there are many points of present saving at the risk, if not the certainty, of future loss. It costs much less to use the ordinary porcelain door-knob for out-of-doors insulation. Yet even with the best insulated cable there is positively no real economy in such construction. Neither should a wooden cleat be made to do service for retaining a cable in position. The former, holding as it does by a single screw, is incapable of sustaining the wire or cable securely, and the repeated replacing and renewing consequent upon the use of these knobs, if the line is kept in proper condition, soon far out-balances the price of glass insulators firmly fixed on iron or wood brackets.

Nor should wires crawling along the face of buildings be fastened to the cornices or water tables. Carried out from the wall by an iron bracket, and attached to glass, two great advantages are gained. There is no contact with the wall, and the window washer cannot stand upon the wires to break the insulation and thus increase the danger of accident, and the possibility of the conductor being reached by occupants of offices or flats is greatly diminished.

The objection to an iron staple over a heavy wire or cable is that sooner or later the weight of the conductor will sag, weakening the insulation, if not cutting it through completely. The wooden cleat is scarcely better. Experience has shown that upon a line where such cleats are used, the retention of moisture by the wood is almost certain to weaken that point, so that when a ground is developed elsewhere, adding to the strain already existing, the cleat aids materially in the development of the second ground, with its consequent unpleasantness.

It costs a little more at the time, but in all such positions the farther we get from the wall or the wood, with air for both ventilation and insulation, the greater the economy in the long run.

No inconsiderable expense is sometimes incurred in covering arc light conductors within a building with a neat and ornamental moulding. It is pretty but expensive, when, as in an instance where I was a witness after the fact, an unnoticed leak from an imperfect skylight developed a second ground on a heavy circuit, and the insurance fell short of the damage done. In another instance, where wooden cleats were used to confine a cable in a sidewalk area, grounds were developed in half-a-dozen places almost simultaneously from a very similar cause, and an expensive piece of conductor was ruined. In the first of these two instances painting or even bronzing the wire with varnish bronze would have been sufficiently ornamental, and the porcelain knobs could have been treated similarly. In any event but a few days after a line wire is run through a room it has ceased to be a nine-days' wonder, and is seldom ever thought of again. So of lines outside. When first placed everyone sees them, and all sorts of criticism and comment are the order of the day. In a few days the gossipers have some other target for their witticisms or remarks, and the wires are permitted to rest.

There is one exception to this rule. In the experience of almost every central plant management, there is one individual who says that under no circumstances can any electric light wire pass his premises. He seems to have been born a coward, and nothing on the surface of the footstool can make him brave unless it is one free lamp. The economy here is compulsory, and not to be questioned.

Is not the unfortunate condition of affairs at the East, with all its concomitant newspaper and magazine literature, its bickerings, injunctions, and other legal entanglements, traceable either directly or indirectly to a mistaken economy? Is it not fair to presume that at the outset, with a reasonable expenditure in first-class material, much of the business unhappiness and the mental bitterness which the electrical fraternity and the outer world, metaphorically speaking, have been forced to swallow, would have been spared them? A difference of 40 dols., perhaps, 50dols. per mile of conductor, I believe would have worked wonders as a peace and harmony panacea, and left fewer raw spots and blisters on the electrical animal, to be gradually nursed back to health and vigour. I may be wrong, but I strongly incline to the belief that where false or dangerous systems of economy have clashed with legal authority, the savings so accumulated are more than balanced by rebates, legal expenses, loss of patrons through stoppages or poor service, or both, in the long run.

Every new industry is compelled to fight for an existence. If, like the electrical enterprise, it must elbow its way into notice, taking the place of a competitor in the front rank, it must make enemies, and of necessity antagonise those whom it discomforts and crowds to the background. It is not an attribute of the descendants of Adam to submit tamely to rebuffs and usurpation, and no opportunity is ever lost of disfiguring the countenance of the newcomer. To give occasion for and encourage these opportunities by our own acts seems to me to be short-sighted and illogical.

It is true that electric lighting and power have made wonderful and monstrous strides in popularity, considering the youth of their existence, and they will continue, despite every opposition, to grow in grace and strength, till they have relegated to the rear ranks every other form of illumination, and crowded the present clumsy, hot, ungainly engines from their vantage ground, as the circus elephant clears the tanbark ring for the riders. But the public has some voice in the matter, and the higher the standard of excellence to which the electric light and power man brings his work, the more rapidly will the circle of usefulness widen and the more tranquil will his enemies have become.

The parties in whose interest legislation on the installation and use of electricity for illumination was first invoked were unwittingly chargeable for the many setbacks and the want of progress which checked the enterprise in its early days, and not wholly free from blame, though indirectly, for the present troubles. These were the fire insurance people. These men deal only with combustion. There is to them a magic in the word incombustible. Say fire-proof to an underwriter and his heart leaps with joy. It was a sharp trader who exhibited a cotton-covered, painted wire to the insurance people and demonstrated that it did not readily burn. "Just the thing," said the actuary, and the president, and the inspector, and they all smiled at the honour conferred when the cunning merchant baptised it for its godfathers, and called it "The Underwriters' Wire." There is a class of hard citizens who usually have an alias. The underwiters' wire is to-day best known by its nickname.

Another misfortune has been handed down to us from the early days of electrical illumination, which I look upon as one of the original sins of the business. The magneto bell. I have written and scolded and begged to have this abomination sent out of the realm, but, like Banquo's ghost, it will not down. I find it everywhere, and if I ask the party in charge of a plant what his insulation is I am quite often told that it is "first-class; my bell won't ring, no matter how fast I turn it." A short time ago I took occasion to measure the resistance through which I could ring the bell of one of these guaranteed for 15,000 ohms. With a really smart grinder we did manage to get a slight response through 6,500 ohms, and when I included the manager with the first-class line he claimed to have, and turned the magneto crank, the effect was marvellous. He made several florid remarks on the occasion, and bought a bridge set the next day. He has since told me repeatedly that the investment has paid him several times over in line economy.

A magneto has no method of giving information beyond the fact that there is or is not a bad condition of affairs on the line. If there are two or more faults, there is no possible way of distinguishing when the linemen have found one of these, except in a negative sort of manner. So soon as the insulation is raised to a point where the bell refuses to ring, its maximum of usefulness is reached. Take the case of the line just mentioned. A maximum insulation of less than 6,000 ohms resistance would be the best that instrument would show. The waste of current, the unsatisfactory lights, both as to brilliancy and steadiness, the useless labour of the generator, the coal waste, the danger to life and property, all those faults which follow in the wake of such weak insulation, certainly confer no honour on an economy which persists in using an instrument that can virtually do no more than show up a dead ground.

Nor is it any better as a method of testing the insulation of fields and armatures. It is far more potent for mischief than is generally suspected, for the spark generated is of very high tension, and is quite likely to cut across and open the way for a short circuit when next the machine is used by weakening the insulation. And, again, the magneto being the sole dependance of the station, the services of an expert are far more often required than they otherwise would be, while the vexatious delay, the annoyance, and, afterward, the bill, which seems outrageous, cannot be placed to the credit of the economy account. Yet the magneto seems almost as persistent and hereditary as John Calvin believed original sin to be.

The dynamo-man and the engineer, when these are two, are often refused, on the score of expense, the most reasonable demands. A case which struck me quite forcibly I may mention to illustrate my meaning. The attendant at a plant found that a portion of the paper driving pulley was becoming loosened, and that in order to restore it to its normal condition he needed a peculiar form of wrench. The manager was notified, but refused to allow the purchase, although the sum required was but a few cents. He said the company could not afford it, and the engineer must get along the best he could. He did the best he could, and so did the pulley. It went to pieces. The dynamo belt went into the engine governor gearing, and the entire plant had a three days' vacation. The lost time, rebates, and repair bills would have paid for several bushels of such wrenches as were needed to repair the pulley. There are other and many simple but necessary appurtenances of use and convenience too often refused on the score of economy which repay the original investment many times over during their existence.

Coupling up high-potential dynamos in series to save wire is doubtful economy, to say the least. Insulation subject to damage from within as well as from without, and two lines of 30 lamps each will last longer and pay better than one with 60 lamps run by two 30-light dynamos in series.

When renewing, the belting of a plant is sometimes a matter of considerable anxiety; occasionally the desire to get a few more days' service out of an old one involves possibilities which may be extremely hazardous. The chances, in case of a break, of the belt becoming playful and familiar, always suggests to me that belts are like oil paintings—made to look at, not to smell of. Yet many a belt has been thrown away as useless because of its having become accidentally greased to that extent that it refused to hug the pulleys. This may be remedied by covering the driving pulley with a leather band, the width of its face, fastened on with counter-sunk bolts. In a comparatively short time the belt, provided it is not again greased, will, by a centrifugal force and evaporation, rid itself of the oil and wear to a good old age.

There is excellent economy in the encouragement of the expert and his assistants, who are, when worthy, the prime support and king-bolt of the business. The hours of such an employé are almost undefined—undefinable. He is, perhaps, taxed beyond his endurance, and many such a man has been lost to his employer through attempted economy in riding a free horse too hard. It is, however, no trouble to supply the place of one who desires to leave a situation. The woods are full of electrical shoddy, and there are plenty of men who claim the title of electrical engineers, and sport a card showing them to be both mechanical and electrical experts. They generally have a place—they call it a position—where a plant is run on an assumed economical basis. Usually these do not last longer than to have made themselves unduly expensive to their employers.

(To be concluded.)

ALTERNATE-CURRENT MOTORS.

Of the making of patents there is no end, and few are worthy of record. Our rule is not to notice specifications of patents, but to wait till the machine is actually before us. Yet there are exceptions to the rule, and one exception is to be found in the Patent No. 3,424, 1889, granted to Mr. Swinburne. Discussing not long since with Mr. Swinburne the value of the various alternate-current motors described during the past two or three years as solving the great problem, we were given to understand that Mr. Swinburne had attempted the problem, and the patent described by this specification is the result. The value of Mr. Swinburne's work must be determined hereafter, the direction in which he has been working may be indicated now. This will best be done in the words of the specification. Mr. Swinburne says:

To avoid lead of brushes in dynamos and motors, and the consequent back ampere-turns, I use reversing magnets.

A sort of subsidiary armature core consisting of a ring of wires or discs is placed inside the connections to the commutator, so that the commutator connections lie on its outer surface, or in grooves milled out of the discs. A little field-magnet is arranged so that the connections come under it, so as to have the necessary E.M.F. induced at the right time or place. When the connections lie on the outside of the reversing armature core they are made very thin, so that the reversing field-magnets may have their pole-pieces brought close to the iron of the reversing armature. As each of the connections has a current for only a very short time each half revolution, the heating is inappreciable. The reversing magnet is wound in series with the main circuit, and may be mounted on the bed-plate or fixed to the bearings in any convenient way. The reversing magnets may be moved with the brushes to regulate the dynamo. If the dynamo is large it may be made to give constant E.M.F. as a generator, or constant speed as a motor when shunt-wound by giving the brushes and reversing magnet the requisite negative or positive lead.

Alternating-current motors, as at present designed, are either special machines or machines resembling alternating-current dynamos. My invention refers to the latter class. At present the usual way of utilising such machines as motors is to design them so that they are kept in step with the generators by their self-induction, or, as I prefer to explain it, by their own unassisted armature reactions, which is a wasteful way of working; because the maximum armature current and back E.M.F. are not at the same times. According to my invention an alternating-current motor is designed so that at any instant its back E.M.F. is just less than the E.M.F. on its terminals by enough to cause the armature current needed to give the power. At no load such a motor should give a back E.M.F. which at any instant is almost exactly equal to the terminal E.M.F. At full load the field is weakened enough to let the necessary current pass, so that the motor does not need to lag much and weaken its field by the reaction of its armature current.

I produce this effect in several ways. According to one method the motor is self-exciting. The field-magnets are excited from a commutator in connection with a special armature circuit, or on starting with the main circuit. After the motor is started I prefer to excite it from a special armature circuit. To avoid sparking it is sometimes advisable to have two exciting armature circuits and two commutators. Two field-magnet circuits are then arranged so that the alternating currents produced in them differ in phase by a quarter of a period. A closed coil may also be wound on each of the field-magnets so as to prevent any perceptible fluctuation of the excitation. In most cases this is not necessary. This method of excitation may be used either for alternating generators or motors.

In the case of a motor the exciting circuits are so arranged that at no load the field excitation gives a back E.M.F. approximately equal to the E.M.F. in the mains. If it has very nearly the same back E.M.F. the motor at no load becomes cophasedly synchronised and takes just enough current to drive it and give power for excitation. It is best to allow a margin so that the back E.M.F. is a little less than the main E.M.F. The motor then leads a little at no load. This slight lead allows a small armature current to pass, which strengthens the field by reaction. This increases the excitation, as the exciting coils in the armature come under the influence of the same pole-pieces. This increases the back E.M.F., so that neither the lead nor the armature current becomes excessive. If too much margin is allowed, the motor will lead too much, and will take a large current at no load, which is wasteful.

When load is put on, the motor begins to lag. The armature current then reacts on the fields and weakens them; this weakens the field excitation, as the exciting coils are influenced by the same field-magnets, and the field can thus be weakened enough without much lag. The field excitation should be so designed that the iron is not highly magnetised. On the other hand, it must not be too sensitive.

Though in my provisional specification I proposed to use a double field circuit, as just described, I now prefer to use a single field circuit connected with the double armature exciting circuit. The two armature circuits are then coupled up to a commutator as in an ordinary closed or open armature circuit direct-current machine. The field excitation is then still affected by the main armature current's reaction on the field-magnets.

The field excitation may be lessened more directly at full load by passing the main current of the motor round the field-magnets after commutation. This arrangement can be employed when the machine is separately excited. This main or series demagnetising current may be taken round the field-magnets of the exciter, instead of round the alternator field-magnets, but I prefer to act on the alternator magnets.

All these methods depend for their final adjustment on the lagging of the motor as the load increases, but instead of being considerable the lag is small, because the current-turns round the field-magnets are fewer at full loads than at light loads.

As the problem of running alternators in parallel as generators is akin to that of running them as motors off parallel supply circuits, machines made according to my invention are suitable for parallel running generators. For instance, if two or more self-exciting alternators of the kind described are in parallel, and one falls behind, or lags a little, its field is at once weakened in a much greater degree than it would be if the ampere-turns on it remained constant.

If the motors with backward mains or demagnetising field circuits in series with the armature are used as generators, the direction of the main currents is reversed, and they become compound-wound alternating-current dynamos; and they may be coupled up to run in parallel, like direct-current compound-wound generators.

To start an alternating motor I use . . . starting by connecting batteries with the direct-current exciter; starting by turning the alternating current into the exciter, which has, preferably in this case, laminated magnets; or starting by connecting the armature and field-magnets of the motor with the alternating current.

The method I prefer is to shift the brushes of the series circuit on starting, and to turn on the alternating current gradually. The brushes are shifted back to their normal position when the motor has attained its normal speed.

When there is no series circuit, and there are two armature exciting circuits and two field circuits to correspond, the motor may be started by putting one field circuit with its commutator in series with the armature circuit, and passing the main alternating current through. When synchronism is attained the connections are altered. The necessary connections for such alterations are more easily arranged in machines in which the field-magnets revolve, while the armature is stationary.

A special commutator may be used for starting only, as the sparking is rather destructive before synchronism is attained. Secondary cells are most convenient for starting large motors, in which the sparking is most serious when started with an alternating current. Secondary cells may be used to start a self-exciting motor, especially when two armature circuits and one field circuit are used. The cells are used to bring the motor up to speed, or a little above speed; the alternating current is then switched on through a resistance. The cells may be charged again two in parallel, with a resistance in circuit, but should not be left on when the motor has a load, as they would interfere with the variation of the field excitation.

Description of the Drawings.

Nine figures illustrate the specification. It will not be necessary for us to give the whole, for in his paper before the Institution Mr. Swinburne has partly referred to the work embodied in this specification. Thus Figs. 1 and 2 here given are given as Figs. 12 and 13 in the paper, *vide* p. 153, February 21st, and other figures in the paper explain more fully the system. The illustrations herewith given are numbered as in the patent specification. Figs. 3 and 4 are diagrams showing the commutator sections and connections of alternating-current motors. F is a ring armature. For the sake of simplicity a two-pole machine is taken, though in practice it is better to have six or more, so that the speed is not too great. H H are the active coils or main coils of the machine. They are connected to collecting rings as usual, which are not shown in the diagrams. I, I, I, I are the exciting coils of the armature. In Fig. 3, two commutators are shown, one within the other; they are actually mounted on a hob, side by side, and are of the same diameter. The connections are made, as in many arc machines, by connecting the pairs of brushes in parallel. The insulating spaces may then be made large, so that each coil is cut out of circuit for a time, when it is giving little or no E.M.F. The brushes and pairs of coils may be connected in series, as shown in Fig. 3. In that case the insulating gap is small, so that there is always a circuit through each commutator. Insulating sections may, even in this case, be used to cut the coils out of circuit when not active, but they must, of course, be connected across. The opposite coils are shown connected in parallel; they may be coupled in series. The brushes are in connection with the field-magnets by the leads, K L. If the armature is stationary and the field rotates the brushes are connected to the armature coils, and the sections of the commutator to the field circuit.

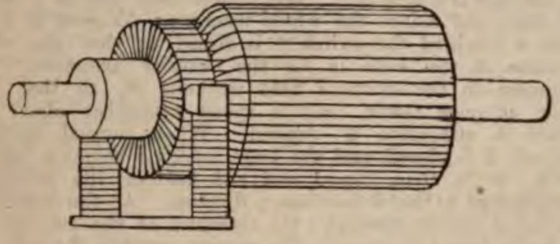

Fig. 1.

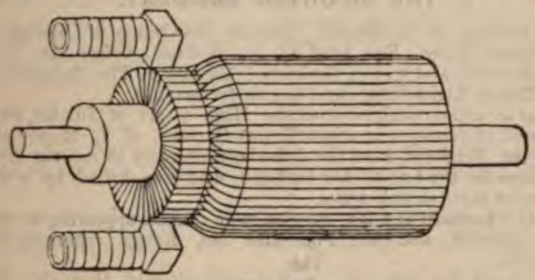

Fig. 2.

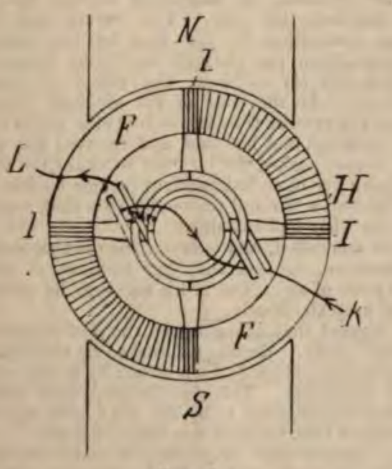

Fig. 3.

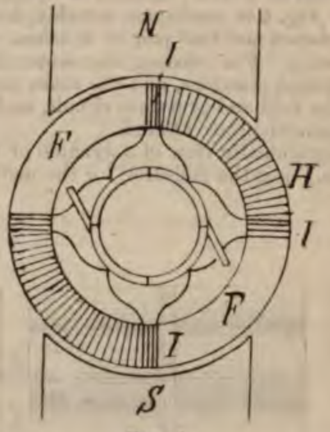

Fig. 4.

In Fig. 4 the exciting coils are connected up as in a Gramme ring. This arrangement demands four brushes and two sections when the armature is stationary and the field rotates.

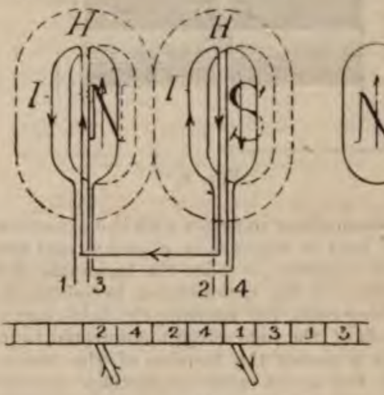

Fig. 5.

Fig. 5 is a diagram of the exciting armature coils in a machine whose armature is made of flat strip without an iron core. The artist has shown the main coils, H H, and pole-pieces, N S N, with parallel sides, instead of radial, for the sake of simplicity. The main armature coils are shown as dotted flat oval coils, H H. They are connected to collecting rings in the usual way, and the connections are not shown. Inside the main coils, in the space at present generally left vacant, are pairs of exciting coils shown as full lines, I I. These coils are more clearly distinguished in Fig. 6, where the main coils, H H, are omitted. N S N are diagrammatic representations of the pole-pieces in Figs. 5 and 6. The arrows on the pole-pieces show the direction they induce a current when a conductor passes from right to left. The arrows in the coil circuits show the direction of the induced exciting currents.

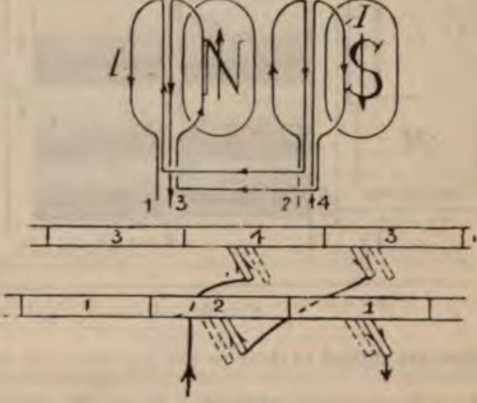

Fig. 6.

In Fig. 5 two pair of coils are shown. Each pair is connected in series. 1, 2, are the ends of one pair, and 3, 4 the ends of the other pair. In an actual machine, instead of two pairs there are two sets of correspondingly situated coils, coupled, preferably, in series. Below the diagrams of the coils in Figs. 5, 6 are diagrams of the commutator sections, and the brushes, which are connected with the field-magnet circuit. The numbers on the commutator sections show which ends of the coils, I I, are connected to them. In Fig. 5 each set of active coils is in circuit when it has an E.M.F. induced in it, the other set being out of circuit. Fig. 6 is analogous, roughly, to Fig. 3. There are two commutators and two pair of brushes, and the sets of coils are in series. For starting the motor the brushes are shifted to the dotted positions, and the main current is passed through both the field and armature circuit, and when speed is attained the connections are altered.

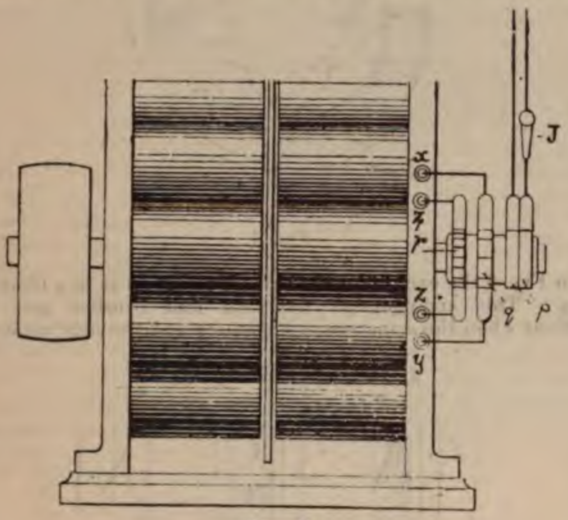

Fig. 8.

Fig. 8 is a diagrammatic view of a dynamo or motor according to my invention. p is the collector for the main armature current, q is the commutator in series with the armature circuit for weakening the field in the case of a motor, and strengthening it in the case of a dynamo, $x\ y$ are the terminals of the main or series field coils, r is the commutator in connection with the armature exciting coils, for exciting the field-magnets, and $z\ z$ are the terminals of the field circuit connected to it. To start the machine as a motor the brushes of the series circuit are shifted so that the series wire magnetises instead of demagnetising. The main current is then turned on through a safety resistance. When the machine has reached its normal speed the brushes are shifted to their proper position, and the load is put on.

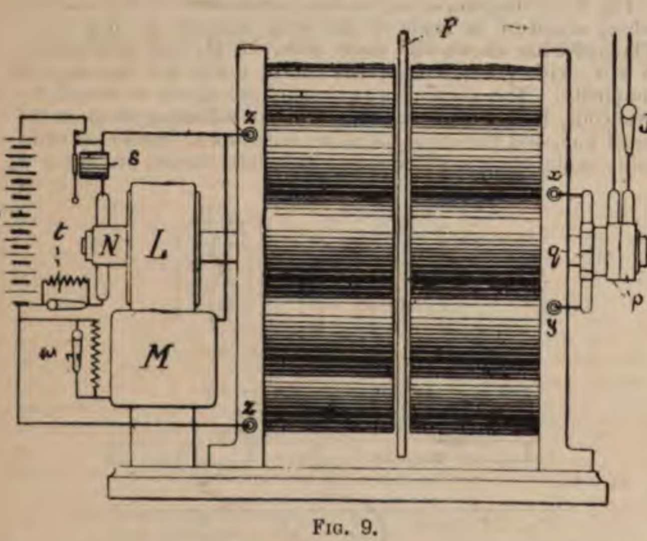

Fig. 9.

Fig. 9 is a diagrammatic view of a separately excited alternating motor, with secondary cells for starting it by their action on the exciter; p is the ordinary ring collector for the main armature current; q is the commutator for rectifying the main armature current before it is passed round the fields to demagnetise them; $x\ y$ are terminals connected with the main, series, or demagnetising circuit round the field-magnets, and with the brushes bearing on the commutator, q. The exciter is shown to the left. L is one pole-piece, M one shunt field-coil, and N the commutator. There is no series-winding on the exciter. O is a secondary battery, which is in shunt to the exciter when the armature of the electromagnetic cut-out, s, is held on. If the motor is running at its normal speed the exciter charges the batteries when the armature of the cut-out, s, is held on, and also excites the field-magnets of the alternator, as the brushes of the exciter are connected with $z\ z$, which are the terminals of the exciting coils of the field-magnets of the alternator. To start the motor the switches, t and w, are opened, J being already open, and the armature of the cut-out, s, is held on. The secondary battery then discharges by three paths in parallel, namely (1) the armature of the exciter, through the resistance in shunt to t, by the commutator, N, of the exciter, and through the cut-out magnet, s; (2) the shunt coils of the exciter, through the resistance in shunt to w; and (3) through the main exciting coils of the main machine connected with the terminals, $z\ z$. The resistance in shunt to t is to prevent an excessive armature current when the cells are switched on while the machine is still at rest. The exciter then acts as a motor, and starts and drives the whole machine. As soon as a fair speed is attained the switch t is closed, so that the whole pressure of the cells is on the exciter armature. The resistance in the exciter's field weakens it, so that as a motor it goes faster, and a speed somewhat above the normal is attainable if desired. When normal speed is attained, J is closed, and the large machine begins to act as a motor. w is then closed and the field of the exciter is strengthened so that it becomes a dynamo. At the instant of reversal of current through s the armature of the cut-out falls off, but is drawn on again by the current passing through s to the upper terminal, z, of the main field-magnets. The exciter gradually charges up the cells again. To stop the motor, J is opened. The speed then falls slightly so that the cells can drive the exciter as a motor again, but the reduction of the current through s releases the armature of the cut-out and disconnects the cells.

LEGAL INTELLIGENCE.

THE BRIGHTON ACCIDENT.

On Thursday, at the Sheriffs' Court for the County of London, held at the Court House, Red Lion-square, Holborn, before Mr. Under-Sheriff Burchell and a jury, the case of Garman *v.* The Brighton and Hove Electric Light Company came on for hearing.

It was an action remitted from the High Court of Justice for the assessment of damages, in which Emma Garman, of 7, Rugby-place, Kemptown, Brighton, sued the defendant company to recover £1,000 as damages for the loss of her husband, who was killed by a shock from one of their electric wires.

Mr. C. Chapman and Mr. Higgins were counsel appearing on behalf of the plaintiff, and Mr. Pike and Mr. Ruegg represented the defendants.

In opening the case, the learned counsel said that the defendant company were lighting a portion of Brighton by means of the electric light, and in consequence one of their wires was hung over the premises of Messrs. Abby and Hallett, brewers. The plaintiff's husband, Thomas Hill Garman, was employed there as an engineer and night watchman. On the night of the 14th of July, 1889, he was engaged in the latter capacity, having as a portion of his duty to attend to a vat on the top of the building, over which was hung an electric wire. That wire, it was admitted on the part of the defendant company, was negligently hung in a drooping condition, and the deceased, in attending to the vat in question, accidentally touched the wire. The result was that the unfortunate man was killed on the spot by the current. By the defendants' negligence the plaintiff had been deprived of a husband, who had left six children, the eldest of whom was only eight years of age. At the time of the accident there was a child unborn, but at the present time it was just nine weeks old. Deceased was a steady workman and husband and received 22s. per week. He (the learned counsel) asked the jury not to award the widow damages that would bring her in an independent income for life, but to award to her and children a fair and reasonable sum that would compensate them for the loss they had sustained.

The plaintiff was called, and bore out the opening statement, while, in cross-examination, she said that her husband at the time of his death was 32 years of age. Out of his earnings he gave witness 20s. with which to keep the family.

Dr. Lowe deposed that he conducted the post-mortem examination on the deceased's body. He was astonished by the healthy condition of the man, who had evidently been struck by a wire containing over 2,000 volts of electricity. This was the immediate cause of death.

This evidence was objected to by Mr. Pike, although the defendant company admitted that the wire was fully charged.

An actuary proved that calculating a man's life from insurance grounds, at the age of 32, and a weekly wage of 22s., the amount would be £1,090. 12s.

Mr. Pike, for the defendants, said that it was a very unfortunate accident for the poor woman, but the jury would have to banish all thoughts of sympathy from their minds and render justice to both sides.

The jury, after a short consultation, returned a verdict for the plaintiff, and awarded £800 as compensation, £200 for the widow, and £100 for each child.

Judgment was accordingly entered with costs.

COMPANIES' MEETINGS.

NEWCASTLE DISTRICT ELECTRIC LIGHTING COMPANY.

The shareholders of this Company held their second annual meeting on the 19th inst., at the Crown Hotel, Newcastle, Mr. J. D. Milburn occupying the chair. There were also present Sir Benjamin Browne, the Hon. C. A. Parsons, Mr. H. C. Harvey (company's solicitor), Mr. J. B. Simpson, Mr. F. J. Snowball, and J. Patterson (secretary).

The following report was taken as read: "The Directors have to report that the Company's central electricity supply station is now in full working order, and that up to the present arc and incandescent lamps, equivalent to 2,100 10-c.p. lights, have been connected to the mains of the Company, and the work is proceeding for switching on further lamps, equivalent to 3,500 10-c.p. lights. The Directors anticipate that in a very short time the Company will have sufficient business to take up all the electric current which the present plant is capable of supplying. The delay in receiving the Board of Trade license for the Company to proceed has been got over by the Directors being able to come to a private arrangement. It is as yet too early to give an accurate forecast of the financial prospects of the Company, but the Directors have no reason to alter the favourable opinion as to the future of the Company that they have always held. Sir Benjamin Chapman Browne and Mr. Arthur Fenwick Wade are the retiring Directors, and offer themselves for re-election."

The **Chairman**, in moving the adoption of the report, referred to the difficulty which arose in consequence of a technical error in the draft Board of Trade license at the moment that the license should have been handed to the Company. After waiting several weeks the Directors resolved to appeal to the Mayor and Corporation for leave to lay down their mains pending the receipt of the license from the Board of Trade. The Corporation considerately granted the Company's request under certain conditions, and every effort was put forth by all connected with the working of the Company to make up for lost time. In order to minimise the inconvenience to the public, through the lifting of flags and crossings, an arrangement had been made between the Company and the Newcastle Electric Supply for the division of the town into two districts, with the exception of the Quayside, which was neutral ground or common to both. As regarded prospects, business was flowing in steadily. The total number of 10-c.p. lamps which could be efficiently connected with the Company's station as at present completed would be about 9,000, of which probably not more than 6,000 or 7,000 would be simultaneously in use, thus leaving one generating machine and boiler always in reserve. Up to the present the Company had connected with their mains 41 installations, representing from 3,000 to 4,000 10-c.p. lamps, and orders for current have been given for about 1,500 or 2,500 more, and many others were in prospect. It would appear, therefore, the Company would shortly have more business than it could manage without increasing its generating power, and it might be necessary ere long to expend more capital to make such increase. Having referred to the judicious provision made for future requirements, and observed that the Company had space for generating plant equal to eight or ten times its present productive power, he went on to say that the managing director (the Hon. C. A. Parsons) had recently been experimenting with arc lighting in conjunction with the alternating-current system, which was the system adopted by the Company. Several large arc lamps had been erected and been very successful, and the Directors believed they would be able to undertake, at an early date, the partial lighting of the streets of this city, especially where brilliant illumination was desired. Alluding to the uses and demands for electricity, he said it was to the tramways that they must first turn their anxious attention. He believed the directors of these would not remain long in the background when a safe and economical scheme for electric traction had been indicated to them. Last year, when he announced the policy intended to be pursued by the Directors of the Company, he had said there was no intention to enter into any insane competition or into a death-grapple with gas, and he thought that it would be some time yet before electricity would vie in cheapness with gas. He denied that the electric light was more dangerous than other lights, and remarked that, if properly conducted, accidents were very rare. In England there had been a great immunity from accidents, and this he attributed to the extra care exercised in these matters by the Board of Trade. The light as supplied by this Company has given great satisfaction to its consumers. Not one single hitch or accident had taken place, and not a single complaint had been made, and they had every reason to be extra proud and satisfied with the high quality of the light supplied. He complimented Mr. Parsons upon his management; the engineers of the Company, Messrs. Hunter and Bigge; and also Mr. Patterson, the secretary. He concluded by saying that altogether the Directors had very great pleasure in stating that they were perfectly satisfied with the scientific department of the Company. They could not very well yet, from the experience they had had, go into the financial prospect, but so far as they could say, and so far as their experience had gone, they had every reason to hope for success. They were doing their best in every direction to increase the business of the Company and to keep down expenses. They hoped that next year, when they came before the shareholders then, to lay a satisfactory report before them and to be able if possible—they could not make any promise—to give them some substantial history of their operations.

Sir Benjamin Browne seconded the adoption of the report, which was agreed to.

Sir Benjamin Browne and Mr. A. F. Wade, the retiring Directors, were re-elected, and Messrs. Strachan and Hill were again appointed Auditors.

It may be stated that the Company have laid down 14,200 yards of main cable, and that the smallest cable is capable of carrying a current sufficient for 1,000 10-c.p. lamps. There are four circuits in the city—one for the Quayside, two for Grainger-street, and one for Clayton-street and Barras Bridge.

The meeting closed in the usual way.

DIRECT SPANISH TELEGRAPH COMPANY.

The thirty-third ordinary general meeting of the Direct Spanish Telegraph Company, Limited, was held on Monday at Winchester House, Old Broad-street.

Sir James Anderson presided, and in moving the adoption of the report observed that they had earned £1,592 in excess of the amount realised in the corresponding period of the previous year. They had carried 17,260 more telegrams, or 155,192 more words, and he was pleased to see that in the half-year under review there had not been any further decrease in the length of the messages, which averaged 10 48 words. Ever since code language and the word tariff had been introduced by the companies there had been a steady persistency on the part of the users of the cables to reduce the number of words in their telegrams, until at last, in their own Company, they had reached the point at which 35 per cent. were below five words. Were the reduction of the length of telegrams to stop where it now was they might take comfort from the fact that merchants could now use the telegraph for small transactions—for business which might come to nothing, and for enquiries that led to no profitable result. The growth of telegraphy was no doubt due to such causes. Unfortunately, whenever there was a reduction of tariff, there was a loss to begin with. They knew that at the coming telegraph conference, to be held in May next, some new terms would be proposed. Some of the administrations looked with an unfriendly eye on their poor 4½d. a word, but, happily, other administrations considered that reductions had gone too far, and the great majority of the European States were losing money on their telegraph service. The expenses of the Company had increased by £690. They recommended a dividend at the rate of 6 per cent. per annum on the ordinary shares, leaving £846 to carry over. They had £60,000 of debentures at 6 per cent., and some plan ought to be adopted for dealing with them when they became due in 1894, either by a special reserve, by calling up the £1 per share still uncalled, or by an increase of ordinary capital; or the debentures might be renewed at a lower rate of interest if their reserve was as good as they hoped it would be when the time came. They felt that 6 per cent. was as much as they ought to divide for the present. He was happy to be able to state that France had given them the use of a direct special wire between the Paris Bourse and their Marseilles office, so that the transmission of their telegrams to and from Barcelona was much accelerated, and their traffic in consequence had increased. Spain had also given them a good wire from Bilbao to Madrid.

Mr. E. Etlinger seconded the motion.

In answer to **Mr. John Newton,** who expressed a hope that the coding system had not yet reached perfection,

The **Chairman** stated that the Company now received about a halfpenny a word net. If that were to be reduced it would be a new terror for them. Fourteen of the Continental States were losing money by their telegraph service; but, unlike the Company, they had the taxpayers to fall back on.

The report was adopted, and the dividends recommended were afterwards declared.

TELEPHONE COMPANY OF EGYPT, LIMITED.

The seventh ordinary annual general meeting of this Company was held on Tuesday at the offices, Austinfriars.

General Alexander Fraser, C.B., who presided, said that they were now established in five places in Egypt—namely, in Alexandria, Cairo, Mansourah, Zagazig, and Port Said—and they hoped soon to be able to open at other places. They had been able, with the assistance of Mr. Grëwing, to obtain the co-operation of Sir Rivers Wilson in getting permission from the Suez Canal Company to lay a cable across the Canal so as to secure telephonic communication with the other side of that waterway. This would enable them to increase their subscribers at Port Said and other places on the Canal. In their report they said that they did not think there would be a great development of business at Cairo and Alexandria for the present, but he thought that, when the prosperity of Egypt increased, their business would be also augumented. After alluding in terms of praise to the manner in which the Company's business was conducted both in London and in Egypt, he concluded by moving the adoption of the report and accounts and the payment of a dividend of 6 per cent. for the year on the preference shares, tax free.

Mr. Henry Grewing seconded the motion, which was carried unanimously.

The retiring Director and Auditors were afterwards re-elected.

WESTMINSTER ELECTRIC SUPPLY CORPORATION, LIMITED.

An extraordinary general meeting of the shareholders of this corporation was held on Wednesday at the offices, 4, Victoria-mansions, Westminster, Lord Suffield presiding, and the resolutions passed on the 5th inst., making certain formal alterations to the memorandum and articles of association of the corporation, in order to comply with the wishes of the Committee of the Stock Exchange, were confirmed without discussion.

NEW COMPANIES REGISTERED.

Durand Electric-Petroleum and Gas Engine and Manufacturing Company, Limited.—Registered by H. M. Green, Havant, Hants, with a capital of £100,000 in £5 shares. Object: to acquire the business now carried on at 163, Avenue Victor Hugo, Paris, by Eugene Durand, with all the patents, inventions, and contracts connected therewith. The first subscribers are:

	Shares.
J. D. Cahill, 6, Great George-street, Cork	1
T. B. Wells, 6, Pembroke-square, W.	1
F. Davies, 22, Davies-street, Berkeley-square	1
J. Russell, 175, Strand	1
F. Street, 16, Victory-square, S.E.	1
C. Furtado, 172, Oakley-square, N.W.	1
P. E. Patchett, Rhiewport, Hornsey	1

Registered without articles of association.

Elmore's Wire Manufacturing Company, Limited.—The first subscribers to this Company are:

	Ord. shares.
E. W. Lamffrett, 18, Church-road, Willesden	1
J. A. Pledger, Upper-terrace, Springfield, Chelmsford	1
J. Rickard, Elvaston, Dulwich	1
A. Stevens, 11, Queen Victoria-street	1
A. Smith, 21, Stratford-road, Walthamstow	1
R. S. Jennings, 5, The Limes, Forest-gate	1
J. Shurmur, 4, Gilbert-road, Lambeth	1

The first Directors are Sir J. H. Morris, K.C.S.I., E. J. Carson, J. MacFarlane, J. J. Atkinson, J. T. Cooper, G. Smith, and W. Elmore. Qualification, 250 shares. Remuneration: Chairman, £300; other Directors, £200 each and 5 per cent. of net profits after 20 per cent. dividend.

Electric Meter Company, Limited.—Registered by Walter Webb and Co., 23, Queen Victoria-street, E.C., with a capital of £50,000 in £10 shares. Object: to enter into an agreement providing for the sale to the Company of letters patent relating to electric meters and other rights; to carry on business as electricians, mechanical engineers, and manufacturers of electrical apparatus and appliances. The first subscribers are:

	Shares.
A. C. Paritt, 94, Sandringham-road, Dalston	1
J. Barlow, 6 Charlotte-street, Portland-place	1
A. F. Stokes, 5, Birchin-lane	1
H. J. W. Frost, 235, Queen's-road, New Cross	1
H. Comins, 3 and 4, Great Winchester-street	1
G. J. Lusk, 75, Chancery-lane	1
H. Turner, 1, Stanley-road, Wimbledon	1

There shall not be less than three nor more than seven Directors; first to be appointed by the subscribers to the memorandum of association. Qualification, £100. Remuneration to be determined in general meeting.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The receipts for the week ended March 21 amounted to £5,176.

Globe Telegraph and Trust Company, Limited.—The Board of this Company notify an interim dividend of 2s. per share, payable on the 18th proximo.

Anglo-Portuguese Telephone Company, Limited.—This Company have declared an interim dividend at the rate of 4 per cent. per annum, less income tax.

Notting Hill Electric Lighting Company, Limited.—This Company notify that share certificates are now ready, and can be exchanged for the bankers' receipts for amounts paid on application, allotment and first call.

Western and Brazilian Telegraph Company, Limited.—The receipts for the week ended March 21, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,991.

Eastern Extension, Australasia, and China Telegraph Company, Limited.—This Company state that the accounts to December 31 last show a profit balance of £139,744, after payment of three interim dividends. The Directors now propose to distribute on April 23 the usual dividend of 2s. 6d. per share, making a total of 5 per cent. for the year. It is proposed to pay a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. The balance of £58,494 has been carried to the reserve fund, which now stands at £710,113.

PROVISIONAL PATENTS, 1890.

MARCH 17.

4103. **Improvements in electric arc lamps.** James Campbell, 212, St. Vincent-street, Glasgow.

4116. **Improvements in magneto call bell generators.** Frederick James Young, 52, Clerkenwell-close, Clerkenwell.

4125. **A new and improved electric bell.** Emanuel Berg, Berlin W. Link-street 29, Germany.

MARCH 18.

4189. **The ball socket switch for electric lighting.** Frank Suter, 276, Strand, London.

4191. **Improvements in method and mechanism for generating heat, steam, and light by electricity.** Theophilus Davies Farrall, 52, Chancery-lane, London. (Complete specification.)

4220. **Improvements in switches for opening and closing electric circuits.** Henry Capel Lofft Holden, Royal Arsenal, Woolwich.

4232. **An improved construction of incandescent electric lamp.** William Ernest Gray, 6, Bream's-buildings, Chancery-lane.

4242. **An improvement in electric railway signals.** Alexander Siemens, 28, Southampton-buildings, London.

4246. **Improvements in primary batteries, and in apparatus connected therewith.** Sir Charles Stewart Forbes, Bart., 23, Thurloe-square, London.

4260. **Improvements in or appertaining to electrical distribution.** William Phillips Thompson, 6, Lord-street, Liverpool. (Charles Griffith Young, United States.)

MARCH 19.

4275. **Improvements in electrical switches.** John Augustine Kingdon, 29, Marlborough-hill, London.

MARCH 20.

4337. **Improvements in electrical, steam, or other power, or hand cranes, or other apparatus for raising and lowering.** Reginald Bolton, 55, Chancery-lane, London.

4350. **Improvements in apparatus for the closing and opening of electric circuits.** Harry Theodore Barnett, 7, Blenheim-terrace, London.

4366. **Improvements in electrical thermometers or electrical instruments sensitized by heat for use in electrical meters and other electrical apparatus.** Thomas Hugh Parker, 55, Chancery-lane, London.

4383. **Improvements in the preparation of active or storage material for use in secondary batteries or accumulators.** James Pitkin and Henry Capel Lofft Holden, 6, Bream's-buildings, Chancery-lane.

4384. **Improvements in plates for secondary batteries or accumulators.** James Pitkin and Henry Capel Lofft Holden, 6, Bream's-buildings, Chancery-lane.

4405. **Improvements in armatures for dynamo-electric machines and motors.** William Brooks Sayers, 71, Norroy-road, Putney, Surrey.

MARCH 21.

4407. **Improvements in electric railways.** James Boyd McGrew, 70, Wellington-street, Glasgow. (Complete specification.)

MARCH 22.

4533. **Improvements relating to safety devices for electric circuits.** Henry Harris Lake, 45, Southampton-buildings, Middlesex. (The Thomson-Houston International Electric Company, United States.) (Complete specification.)

SPECIFICATIONS PUBLISHED

1888.

17163. **Electrical switches.** Rawson and White. 8d.

1889.

3424. **Dynamo-electric machines, &c.** Swinburne. 8d.

3671. **Winding, &c., clocks by electricity.** Boult (Pouchard). 8d.

4846. **Electric light fittings, &c.** Falkenstein and others. 6d.

7127. **Electric railways.** Vaughan (Trott). 8d.

7198. **Electric arc carbons.** Adeney and Saunderson. 4d.

7947. **Dynamos.** Farquharson. 6d.

8459. **Dynamo-electric machines, &c.** Willson. 11d.

12773. **Electric railways.** Wheeler. 8d.

20288. **Conduits for electric conductors.** Tatham and Tatham. 8d.

1890.

1106. **Conduits for electric conductors.** Carpenter. 6d.

1329. **Incandescent electric lamps.** Bonne (Thompson). 6d.

1495. **Storage batteries.** Lake (Johnson). 6d.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Anglo-American Brush	—	2½
— Pref.	—	1⅞
India Rubber, Gutta Percha & Telegraph Co.	10	18
House-to-House	4½	5
Metropolitan Electric Supply	—	5¾
London Electric Supply	5	3
Swan United	3½	5
Crompton & Co., Pref.	—	5½
National Telephone	5	5¼

NOTES.

Vienna.—The Vienna Electrizitäts Gesellschaft has increased its capital by 2,000,000 florins.

Telephones.—The long-distance wire between Breslau and Berlin is so much in demand that it is proposed to establish a second wire.

Telegraph Congress.—All the telegraph companies have been invited to the International Telegraphic Congress which will be held in Paris.

Society of Arts.—A paper is announced to be read on May 14, before the Society of Arts, by Elihu Thomas Fleming, on "Electro-Magnetic Indicator Experiments."

Western Union.—William Waldorf Astor has been elected to fill the vacancy in the directorate of the Western Union Telegraph Company caused by the death of his father.

Board of Trade.—Notices have been sent to the various corporations of the addition of the new clause to the Board of Trade regulations allowing the local authorities to delegate their powers if so desired.

Langhans Lamp.—The Langhans incandescent lamp to which we alluded last week will be introduced into England by Messrs. O. Berend and Co., of 61, Fore-street, who are acting as agents for the Berlin Company.

Execution by Electricity.—A Reuter's telegram from New York states that the murderer Kemmler has been finally sentenced to be executed by electricity at Auburn Prison during the week beginning April 28th.

Rotterdam.—The communal authorities of Rotterdam are studying the question of lighting the city by electricity. Different systems are being tested, and several companies are already at work under immediately terminable contracts.

Chemical Society.—The first anniversary dinner of the Chemical Society was held at the Hotel Metropole on Thursday evening, March 27. The society originated in a meeting of some 25 chemists, held in 1841, of whom now only one, Sir William Grove, was still living.

Change of Address.—Mr. Albert Hoster, engineer and manufacturer and electrician, who has works at Clerkenwell, and in France at St. Nicolas D'Aliermont, with branches at Paris, Barcelona, and Hamburg, has taken offices at 51, Cannon-street, opposite the Mansion House Station.

Fritsche Dynamos.—The French branch of Messrs. Crompton and Co. have made arrangements for the manufacture of the Fritsche dynamo. We believe it is intended to take up the manufacture also in England with energy, and several patents have been taken for improvements in the details.

Oxford Extension Lectures.—The fifth lecture of the course, in connection with the Oxford University Extension, was delivered by Mr. V. P. Sells, M.A., F.S.C., in the Princes-street Lecture Hall, Gravesend, on the subject of "Electric Lighting." The lecturer went carefully through the fundamental ideas of electrical action, and gave a thoroughly interesting and instructive address.

Newcastle.—Though it is less than four months since the Newcastle and District Electric Lighting Company obtained permission to commence operations, they have already 60 installations at work on four circuits extending to one and a half miles from the supply station. They have received the order from the Corporation to light up some of the most prominent parts of the city.

Consent of Lambeth.—An important decision was taken by the Lambeth Vestry at their meeting last week, more fully reported elsewhere, when consent was given to the application of the House-to-House Electric Light Supply Company for a provisional order, such order to extend to the whole of the parish, with the exception of parts already allotted to the London Electric and the Electric Installation and Maintenance Companies.

Electric Traction.—The question of electric traction is a very lively one at this moment in all parts of the world. Not only do we hear of preliminary enquiries at Edinburgh, Lancaster, Hull, Plymouth, Southampton, Dublin, and other British towns, but companies in Christiania, Calcutta, Montevideo, Ceylon, and other parts are preparing for the new power, and we may expect to hear of work in plenty for those who can undertake it.

Electric Launches.—Messrs. T. B. Seath and Co., of Glasgow, are building the four electric launches for the Electric Traction Company which are to be exhibited at the exhibition at Edinburgh. Each of these launches is 40ft. long and will carry 40 passengers. It is intended to ply these for hire in the canal in the grounds for a small sum, and this will be probably the first case in which electric launches have been used in this way for public hire.

Expanding Wire Lamp Guard.—Take a semi-spherical wire case, add four bent wires meeting together above it so as to clasp the lamp holder; fit these movable wires, each couple, with a small sleeve to fix them in position when slipped over the lamp, and you have the simple and useful expanding wire lamp guard patented and introduced by the Sawyer-Man Company for use with their lamps in factories or other places liable to occasional accidental blows.

Lecture.—Mr. Albion T. Snell gave a public lecture at the St. George's Hall, Brondesbury, on Monday, on "Electricity as Motive Power." The lecture was illustrated with motors, dynamos, and other electrical effects, and was a very great success. Mr. Snell particularly enlarged upon the applications that electricity was being put to in modern practice for traction, launches, and mining applications, in the introduction of which the lecturer himself has had so large a part.

Frankfort Exhibition.—The applications for space in the forthcoming Frankfort Exhibition of 1891 must be sent in by 1st July, 1890. The price per square metre is fixed at 15s. in the buildings, 10s. uncovered spaces, and 2s. in the open air, with a rebate of 20 per cent. if over 20 square metres in the first two cases. Herr Leopold Sonnemann is president, and Herr Alexandre Askenasy, secretary to the executive committee. The exhibition will be divided into 20 classes of exhibits.

Catalogue.—Messrs. John and William Roper, of Bradford, have issued their catalogue of dynamos and arc lamps. This firm have done a considerable amount of work in wool and dye mills, factories, and private houses in the North of England, and the illustrations of their new types of dynamos give the aspect of a thoroughly well-built type of machine. Arc lamps are shown for private and public lighting, and particulars are given for installations supplied by Roper's dynamo.

The Southwark Subway.—The electric engines for the Southwark Electric Subway are, we understand, being made for the electrical contractors by the celebrated railway engine makers, Messrs. Beyer, Peacock, and Co. Gearing in the ordinary sense will not be used, the connection being made by sprocket wheels. There is no doubt that the conditions imposed by the necessities of the railway are of a very onerous description, and the second engine that is being built will be of a heavier and stronger type.

Distribution.—Mr. Lowrie, of Minneapolis, president of the American Street Railway Association, who is associated with Mr. Henry Villard in the Meeker Island scheme for generation and distribution of electricity, is working hard for the realisation of two ideas, one the total abolition of any other but electric cars in the conjoined two towns of Minneapolis and St. Paul's, and the other the complete distribution at low price of electric light and power to every house as water is distributed by the water companies.

Hanley.—At the last meeting of the Hanley Town Council, Mr. Emery, in moving the report of the General Purposes Committee, said the Council would be pleased to know that the application of the Birmingham House-to-House Electricity Supply Company to the Board of Trade to enter their borough had been refused. The Council, who had bitter experience of the monopoly of lighting power, refused to give their sanction to the company, and now the Board of Trade had confirmed their decision. The report was adopted.

Combination.—The remark has been going the round that two prominent electric traction interests are to be united. This is probably an allusion to the proposed working arrangement between the Electric Construction Company and the Electric Traction Company. There is, however, no intent to amalgamate or combine, the rumour having arisen apparently from the fact that the promotion and floating of the latter company are not unlikely to be arranged to a large extent by the former, though there is no question of amalgamation.

Electric Railroads.—The chief engineer of the Sprague Company of America, Mr. J. H. Vail, reports that he has lately been a round, stopping at St. Louis, St. Joseph, Minneapolis, St. Paul's, Chicago, Cleveland, and Pittsburgh, at all of which, and others, the company are busy introducing electric railroads, or have already introduced them. The latest improvements which have been brought out to their street railway system are being added. Between 30 and 40 roads are now under contract, comprising from 300 to 400 miles of track, requiring several hundreds of cars.

Liverpool Tramways.—The experimental car for the Liverpool United Tramways has been finished and was inspected last week at Barking, for the Board of Trade, by General Hutchinson, who expressed himself satisfied with the arrangements and working of the car. The gradient in Liverpool being heavy a stronger motor has been put in, 15 h.p. instead of 10 h.p., as used on the previous cars, gearing has been furnished for each axle, and eight blocks for the break instead of four. The car will be run on the Liverpool lines next week. A special charging plant is being also sent down.

Leith.—Lord Balfour of Burleigh, on behalf of the Board of Trade, received last week a deputation from the Leith Town Council with reference to the reasons which had induced the Corporation to refuse consent to the application of the Scottish House-to-House Electricity Company, for a provisional order to supply electricity within Edinburgh and Leith. It was explained that the order was objected to because the inhabitants of Leith had expressed no desire for the electric light, and also because the town had, conjointly with Edinburgh, entered into heavy financial obligations with regard to gas lighting.

Engineers' Certificates.—An important enactment which may be worth consideration by town authorities in other lands, has, we see, been resolved upon in Chicago, namely, that every man must procure a license before he will be allowed to take charge of a steam plant within the boundaries of the city. The engineers themselves have assiduously worked for this point, and at last the ordinance has been passed by the Council. The enactment has of course important bearing upon electrical engineers, as private installations require the presence of an engine man, who will now have to pass a preliminary practical examination sufficient to guarantee his capability.

Knight's Oil-Engine.—The "Knight" paraffin oil-engine is the invention of Mr. J. H. Knight, of Barfield, Farnham. Last week a demonstration of the efficacy of this engine for electric lighting was given publicly at Mr. G. Elliott's Reliance Works, Farnham, where one of Mr. Knight's engines, built on the premises, and which drives Mr. Elliott's machinery, was the motive power for an electric light exhibition. It was the first electric light installation in Farnham, and was greatly admired. Mr. Knight's paraffin oil-engine drove a dynamo supplying eight 16-c.p. lamps, which burned very steadily, and were favourably commented upon by a large attendance of visitors.

North Metropolitan Bill.—We are glad to be able to announce that the North Metropolitan Company's Bill for the introduction of electric traction on all their London lines, amounting in all to 41 miles, has been successfully passed through Committee. It was opposed by the London County Council and the West Ham Corporation. The advantage of the Bill when sanctioned can be easily estimated from the fact that at present the tram company is dependent upon the goodwill of the authorities, who, on 24 hours' notice, can insist upon removing them. Whereas, under the Bill, this notice extends to not less than seven years, an enactment which, of course, makes all the difference to practical working.

Looking Forward.—A good idea of an exhibition in America is to fit up a specimen house or set of houses "à la Bellamy," that is, with all possible present or practical future improvements such as might be imagined to be the usual state of house arrangement at the end of the twentieth century or thereabouts. Naturally electricity will play a very great part in this new household and municipal economy, and exhibitioners might tax their powers to some purpose by exhibiting as far as possible these progressive ideas—electric light, telephony, music, heating, cooking, delivery of packages and messages, traction, power, etc.—all in veritable realisation for everyday use in a model block of houses suitably furnished and arranged.

Jubilee of the Penny Post.—At the Court of Common Council, Guildhall, a letter was read from Sir Arthur Blackwood, secretary to the Post Office, on the subject of the celebration of the Penny Postal Jubilee, and asking the Court to utilise the Guildhall and its spacious library and Council chamber for the purpose of a conversazione, at which should be displayed and illustrated by the Post Office all kinds of postal work and industry, together with electric telegraphy and a collection of the postage stamps of all nations. It was explained that the Post Office was not large enough for the purpose. Alderman Sir James Whitehead moved that the request be complied with and that the arrangements be made by a committee. The motion was carried.

Electric Headlight.—An important point in railway practice to which considerable attention has been given in the United States, is that of electric lamps for engine headlights. Mr. G. H. Prescott, superintendent of the Vandalia Works, is said to have pronounced the electric headlight that they have been testing on two of their engines for three months a perfect success. It throws the light from a half to three-quarters of a mile ahead—far enough to stop a train running 60 miles an hour in time to prevent an accident. Another advantage the light has is that the light is thrown directly in front of the locomotive, and does not illuminate to any extent on either side of the track. Twelve of the Vandalia engines will be equipped with this light.

Ship Signalling.—An apparatus has been invented which is intended for prevention of collision in time of fogs. A large funnel is mounted on the fore part of the vessel and turns round at the rate of five turns a minute. The waves of sound occasioned by the movement of another vessel are received by a membrane and transmitted by means of a microphone to a receiver, which indicates by means of electromagnets from which point of the compass the noise comes. These are indicated by white discs marking the direction, and an electric bell also sounds. Several receivers are intended to be worked from the same transmitter for the captain and also for the engineman, who could stop at once or slow down if the vessel were coming in the opposite direction in a fog.

Aluminium Cells.—A new primary battery was lately shown by the Aluminium Battery Electric Light and Power Company, of New York, which has some features of interest. A large party of experts were present and a number of highly satisfactory tests are reported to have been made. The solution used in the battery is an "aluminium compound," and the elements are carbon and a compound of zinc, tin, and aluminium. The E.M.F. per cell is two volts, and the internal resistance less than ·03 of an ohm. It is said that in the development of this battery some phenomena were observed that were never before met with, and the result was not only a highly efficient battery, but the opening up of certain fields of investigation which might lead to important discoveries.

Contract for Lighting in Galway.—At a meeting of the Galway Harbour Commissioners on March 25th, Major Wilson Lynch, D.L., in the chair, the tender of the Galway Electric Company to light the old and new docks with electric light for a sum of £40 per annum was accepted, subject to the approval of the Board of Works, who have a receiver on the revenues of the port. The water power of the Corrib river is being utilised for the production of the electric light, and the company competed with the gas company for the public lighting of both the town and the harbour. Some of the gas lamps here are guaranteed 100 c.p., and Galway is admittedly one of the best lighted towns in Ireland. The new lights at the harbour will be mostly incandescent lamps.

Ships and Compasses.—Our warships seem, says a correspondent of the *Steamship*, to be threatened by an internal danger which has perhaps caused some of the losses by wrecks and collisions from which the Royal Navy has suffered during the last ten years. The compasses of all iron ships have to be very carefully adjusted to free them from the magnetic influence of the hull, but warships constructed as they now are, entirely of steel, are found of themselves to possess a permanent magnetism which is governed by the direction in which they lay during building. That is, a ship built in a position directly north and south with the bow to the north, will be found to be permanently magnetised, the forward end being a south pole, while the southern possessed north polarity. Under some circumstances on long voyages this magnetism is apt to change slightly in direction, and then the previously adjusted compasses are thrown entirely wrong.

Kansas.—The first trip has just been made over the Northeast electric tramway of Kansas City. Five cars are running and others will be put on. The line is three and a third miles long. The engine-room comprises five large dynamos, representing a combined capacity of over 500 h.p. Two 300 h.p. Babcock and Wilcox boilers furnish the steam. A quarter of a million dollars has been spent upon the line, and it is intended to make it one of the best equipped lines in the country. Another electric line is also shortly to be constructed between Kansas City and the residential suburb. The line will be six miles long, double tracked throughout, and it is proposed to complete the whole outfit and work in 90 days. Besides this, it is stated that another line, one of the longest and best equipped electric lines, will also be carried out from Kansas City, joining it, in another direction, to Independence. This line will be 20 miles long, on the Sprague system, and will cost almost a million dollars.

Cheap Search-Lights.—At San Francisco harbour experiments have been made with the Huntington electric search-light. The search-light hitherto used on American warships is usually a very heavy apparatus, made in France, weighing about 1,000lb., and cost about £2,000. The new search-light weighs only about 130lb., is of 4,000 c.p., and costs £72. One man can easily handle it, and the light is concentrated in parallel rays, instead of being diffused over a wide area, as in those previously used. At the distance of half a mile on a dark clear night buoys could be plainly seen, and every rope in the rigging of a ship. It is claimed that the light will penetrate the thickest fog sufficiently to prevent collisions. An interesting experiment was made by turning the beam vertically, when a column of light three-quarters of a mile high is produced, visible on dark, clear nights many miles away, and visible in the thickest fog at one-eighth of a mile distant.

Bacup.—The Bacup Corporation expect to obtain the consent of the Board of Trade for their provisional order, and apparently intend to commence work upon the earliest opportunity. The central generating station is to be situate at Mashwood, on land belonging to the Corporation, and the buildings will consist of engine and dynamo room, boiler-house, workshop, and offices. The motive power will be furnished by three horizontal compound condensing engines of 65 h.p. each, and these engines will drive the dynamos through belting. In the boiler-house there will be two Lancashire boilers made of steel, and provided with the necessary fittings. The electrical installation wil
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which will be able to generate suff

six arc lights of 1,000 c.p. each, of the Brockie-Pell type of lamp, and 1,500 incandescent lamps of 16 c.p. each. The necessary accumulators, meters, etc., will be provided. The distributing mains will be 2,043 yards in length, and the greatest distance of any lamp from the central station will be 570 yards. The mains will be laid principally under the footpaths, on the three-wire system. The estimated cost of the installation complete is £10,000.

Perreur-Lloyd Installation.—We visited last week at 42, Eagle-street, Red Lion-street, Holborn, an interesting installation of the Perreur-Lloyd process of chemico-electrical manufacture. In effect this is a process of manufacturing electrically chemical substances hitherto produced by heat or other treatment, and yielding at the same time very considerable quantities of electrical current as a bye product. Sulphate of copper in splendid crystals is produced and can be supplied, it is stated, at a price considerably less than the present cost, and the current from the large primary battery formed by the apparatus is used to charge accumulators which are used for lighting the works. The process produces all the metallic salts, sulphates, chlorides, etc., at a price less than the ordinary cost, and by the method of simply distillation (which is part of the process), a large part of the acid is recovered. Electrolytic copper and the oxide known as cement copper can also be cheaply produced. The electricity being a bye product costs nothing, and as the quantity of the current is very large the means can be found in either light, power, or for chemical purposes to utilise it. It remains, of course, to be seen whether the process is practical on a large scale and what effect upon the markets such a process will have. But it is evident that fine marketable crystals of many kinds are being already produced in very considerable quantities.

Editorial Changes.—American electrical journalism promises some new and exciting developments in the near future. We have already announced that the late editors of the *Electrical World*, Mr. T. C. Martin and Mr. Joseph Wetzler, have somewhat abruptly left the paper they have been so long connected with, and have taken the position together as editors of our namesake, the New York *Electrical Engineer*. This week the larger paper briefly announces its change of editorship under the heading of "another step forward," so that although no details or explanation of the rupture have been divulged, it seems to be evident that somewhat strained relations have preceded the event. Other changes are also reported, Messrs. Colvin and Shaw having also left their positions and joined the retiring editors. The engagement is announced as editor-in-chief by the *Electrical World* of Dr. Louis Bell, a well-known professor of high reputation in electrical physics. Meanwhile the N. Y. *Electrical Engineer*, hitherto a monthly certainly with the highest scientific flavour, but naturally less go-ahead than its contemporaries, is to be transformed into a weekly, and it is to be expected that under the spirited direction of the new editors a keen rivalry will be established, in which, taking into consideration the immense scope of the vast continent over whose electrical progress they will keep watch, we wish them both heartily progress and success.

Sunderland.—At the fortnightly meeting of the Sunderland County Council last week the town clerk read a letter that had been received from Messrs. Pinkney and Bolam, solicitors, a copy of which had also been sent to every member of the Council, on behalf of the Sunderland and Southwick Electric Lighting Company, Limited, as to supplying the electric light in the town. Upon that question the Highways Committee has passed a resolution reporting that they are considering the propriety of the Council applying for a provisional order in the ensuing session, and therefore recommend the objection lodged with the Board of Trade be adhered to. Alderman Bell moved the adoption of the resolution. He explained that the company for whom Messrs. Pinkney and Bolam acted had not complied with the rules of the Board of Trade as to asking for the consent of the local authority to their application for a provisional order, and the result was that the order was now virtually dead. Under the circumstances he thought the time had arrived when the Corporation should obtain an order for themselves to supply electric light, and with the consent of the Board of Trade they could transfer their powers to any persons or company. If they did that the town would keep to themselves a certain amount of profit which the town ought to derive from it. Mr. Harrison seconded the resolution, which was adopted.

Solid Accumulators.—We have inspected what may prove to be one of the most important improvements in electric storage batteries, especially for such purposes as traction or other use where rough handling is one of the unavoidable circumstances. This is a dry storage battery, in which the whole cell is much of the same consistency as a bathbrick, and can, therefore, suffer nothing by shaking. The modification mentioned is the invention and patent of Mr. Barbey-Starkey, whose name is so well known by his method of adding carbonate of soda to batteries to prevent sulphating. In the new solid accumulator the interstices between the battery plates are filled with a mixture of fine white wood sawdust soaked in the sulphuric acid solution and mixed with plaster of Paris. This mixture sets fairly hard and the whole cell is practically a solid mass. The cells have been tested experimentally by the Electric Traction Company at Barking, and it seems that, so far as the tests have yet extended, that the combination is very satisfactory. The internal resistance of the battery is not increased and the efficiency is the same, while the battery is only a shade heavier. A few cells have only as yet been tried, and the batteries have not yet been put to a practical working test; but as far as can be judged it seems to present the most hopeful means of getting over that greatest difficulty of electric storage traction, the buckling and consequent deterioration of the plates.

Wire-Covering Machines.—Amongst the numerous accessory branches of industry which have arisen in connection with the enormous development in the use of electricity for lighting, for telegraphic and telephonic purposes, for transmission of power, etc., no branch has shown more steady and intelligent development than the manufacture of machinery for insulating wires, and for the production of electric leads and cables of all descriptions. The price list, which we have before us, of the machinery made by Messrs. Thomas Barraclough and Co., Limited, Manchester, seems to cover all the machinery necessary for the branches just indicated. Page 1 gives particulars of machinery for winding and doubling cotton and other yarns used in covering wires. Pages 2 and 3 give particulars of a great variety of machines for covering wires and strands with cotton, flax, jute, silk, etc. The machines are made in various strengths, so as to deal with everything that may occur, from the largest strand down to the finest wire. Page 4 contains details of a great variety of machines for braiding or plaiting yarns round wires, strands, cables, etc. Page 5 is devoted to setting out numerous machines for applying tapes of all kinds to wires and strands. Thus we have machines for dealing with textile tapes of various kinds, metal tapes, pure indiarubber tapes put on spirally, compound indiarubber tapes put on longitudinally, etc., all being constructed of the most modern form. Pages 6 and 7 are devoted to machines for winding wire of all kinds, and also for making wire cores or strands of any size and number of wires. Pages 8 and 9 are more specially devoted to machines used in the manufacture of large submarine cables, say, for deep-sea, intermediate, and shore end purposes. We are informed that many improvements have recently been made in this class of machinery, more especially in the direction of increased production and reduced cost of attendance. The price list serves to show what an immense variety of machines have become necessary through the great strides in the use of electricity, and we are informed that Messrs. Thomas Barraclough and Co., Limited, are rewarded for their exertions and their great outlay in the introduction of improvements by large and increasing orders.

Gas Opposition at Bath.—The opposition to the electric light at Bath by the gas company is reaching an acute stage. Some time ago they asked for an independent enquiry by an engineer upon the manner in which Mr. Massingham had laid his wires. Major Cardew visited Bath on the part of the Board of Trade; afterwards Mr. G. Harris, assistant of Sir F. Bramwell, accompanied by the gas company's engineer and directors, went over the work, being accorded every facility by Mr. Massingham. This report has not been made public, so was presumably favourable. The gas company thereupon instructed their own engineer, who reported that the electric cables sometimes passed near the gas mains, and when crossing went "over them and sometimes under the gas mains," which does not seem unlikely. Upon the report of the engineer the gas company have drawn up and forwarded to the Board of Trade several objections to the license, the main points being that the undertaker (Mr. Massingham) on receiving not less than 24 hours' notice should forthwith, at his own cost, remove or so dispose of the electric mains so laid by him to allow of gas mains being repaired or inspected; and also that if the undertaker neglects or declines to comply himself, that the company may themselves carry out the work, the undertaker agreeing to switch off the current for so long as it is necessary for such work to be completed. The effect of such a clause, if granted, can be easily seen, and would be disastrous to Mr. Massingham, who would be practically under the control of the gas company, and would be prevented from properly fulfilling his contracts, as at any time they pleased the gas company would be at liberty to insist upon the electric light in any particular district being suspended for any time and for so long as they might choose. Mr. Massingham was willing to agree, rather than submit to the trouble and expense of an enquiry, to any reasonable objection, but the object of the company seems to be to force the enquiry upon him, which must prove a serious drain upon his resources. So strong is the feeling in some quarters in Bath against this course, that a public meeting has been suggested in order to protest against this course and to send representations to the Board of Trade of the vexatious nature of the objections, or if the enquiry cannot be averted, to indemnify Mr. Massingham for the enforced expense.

Edinburgh Exhibition.—The buildings for the Edinburgh Electrical Exhibition are now practically completed, and it is expected that the whole will be ready for the opening on May 1. The scope of the exhibition has been considerably widened, and the machinery-hall, which, according to the first conception, would have accommodated the whole of the exhibits, now forms scarcely one-third of the buildings. It will thus be one of the ordinary exhibitions, but with an electrical section as its most prominent feature. The site is some two miles from the centre of the town, and covers altogether some 90 acres, having two railway stations within the grounds. The recreation ground alone covers 10 acres, and the other out-of-door amusements are very numerous, including recreation ground and running course, the switchback railway, the *chemin-de-fer glissant*, a panorama, etc. The buildings of the exhibition proper cover an area of nearly nine acres. They are constructed almost entirely of wood and glass, and the general design is light and elegant in character, though the management has wisely abstained from extravagant outlay on mere decoration. The general exhibits, both British and foreign, are accommodated in what is called the main building, a spacious hall subdivided into numerous courts, occupying the eastern portion of the site. There also is the large concert-hall, with a grand organ and a commodious orchestra. The main building is connected with the machinery-hall on the west by several annexes and a covered way. Here are the fine art galleries, comprising one court for sculpture and six for painting. The exhibition of pictures will consist entirely of contributions by artists—that is to say, there will be no loan collection; but there will be a good representation of contemporary art, both British and foreign, and nearly all the pictures will be on sale. The machinery-hall, which measures 700ft. by 150ft., will be the most interesting portion of the exhibition, because it will contain those exhibits that differentiate it from other enterprises of the same kind. It will be divided into three portions, the middle one of which will be occupied by some 20 dynamos. The electrical inventions and appliances will be located in the western division, and will include all the different kinds of apparatus for the production and conduction of electricity. Its most interesting feature will be examples of the practical applications of electricity—the telegraph, the telephone, the phonograph, fire alarms, burglar alarms, electric clocks, time telegraphs, electric signals, and electric lighting. There will also be a section devoted to the bibliography of electricity. The general inventions section, occupying the eastern portion of the hall, will include a great variety of machinery and appliances connected with manufactures, mining, engineering, and locomotion. The feature stipulated for by the Electrical Trades Section of the London Chamber of Commerce has considerably contributed to its success in procuring exhibits. This, it will be remembered, is the consideration that space should be granted rent free to exhibitors who are really the source of the interest taken by the public. A deposit of half-a-crown per square foot of space was required, which will be returned if the expenses of the exhibition are paid. This feature is an important innovation, and is exciting considerable interest in other towns and abroad, and it is not improbable that it will form a precedent which all future exhibitions are likely to follow. The Lord Mayor of London will visit the exhibition "in state," and will be entertained [illegible] chief magistrates of the burghs of Scotland [illegible]

DEVELOPMENT OF GENERATING STATIONS FOR INCANDESCENT LIGHT AND POWER.[*]

BY C. J. FIELD.

I desire to present a brief review of the present and near future of central power plants in the larger cities, taking as an illustration one of recent type, describing its general arrangement, then proceeding to the consideration of its initial cost, earning capacity, output, operating expenses and economy, and, in conclusion, trying to indicate the immediate future development in this class of work.

The immediate points to be considered in the designing of central power plant for a large city are many, and they should receive careful survey before any work is proceeded with. We will briefly summarise them as follows:

1. Recognition of the importance of safety and reliability in operation.
2. Obtaining the true economy of output under all conditions.
3. Installing of plant in a building entirely suited to the working of same, and, as far as human ingenuity can provide, proof against destruction.
4. Adaptability to proper and economical working of the plant.
5. Division of the generating power into the proper number of units for the safe and reliable operation of the plant.
6. Flexibility of system—that is, adaptation to furnishing current for light, power, and other sources of revenue, the obtaining of the largest return per dollar invested, and not carrying to excess for the mere sake of engineering by any part of the plant for the obtaining of proper results therefrom.
7. Not installing the plant for mushroom growth, but laying it out for comprehensive business, thereby securing at as early a date as possible the entire confidence of the invested capital.

A careful consideration of these points will prevent trouble later on. Much of the trouble of stations at the present time, in their standing with the community, is due to neglect of this point, and the majority of their failures as well. We must recognise the fact that the public to a certain extent have become prejudiced somewhat unjustly, but this is all the more reason for better and more conservative management and good construction. No more inviting field is offered for either investing capital or good engineering than central station for lighting, power, and railway work.

I propose to take as a representative type, showing the present development and first-class work, the station of the Edison Electric Illuminating Company, of Brooklyn, completed last fall and now in successful operation.

In the arrangement of this plant there was somewhat of a departure from previous general practice, the company trying to secure the benefit of past experience in the larger stations of this class, both in the kind of arrangement and of apparatus used, trying to secure at as economical a cost as possible the best plant. As will be seen by the longitudinal section through the building, the general arrangement is as follows.

The boilers and engines are located on the first floor, the engines being on the front half and the boilers at the rear, thereby bringing everything on this part directly under the eye of the chief engineer, making it much better than where the boilers are located two or three storeys up; this was obtained by spreading out a little more on the ground. The boilers are Babcock and Wilcox's largest type of sectional water tube boilers. The engines are 300 h.p. compound, horizontal, automatic engines, manufactured by the Ball Engine Company. Each engine is directly belted to two generators. The plan of the engine and boiler room floor will also show in more detail the general arrangement here used, and, I think, needs no further explanation.

Ascending to the second floor, we reach the electrical part of the plant. Here are located in the front part of the building, directly over the engine-room, 24 dynamos, each with a capacity of 750 amperes and 140 volts. Each dynamo weighs about eight tons. Overhead travelling cranes are installed here and in the engine-room for ready and quick handling of all apparatus. Through the centre of the dynamo-room is located the electrical gallery. From here are controlled the workings of all the dynamos, and other apparatus, also all outside lines; everything in connection with handling, generation, and furnishing of current is directly under the eye of one man in this gallery, and from which he has a general view of the dynamo-room floor and the workings of the dynamo, a second man being on the floor to see to the bearings and brushes. From this gallery run all the feeders, which connect into the network of mains, covering over an area of about one and one-half miles square. The ampere-meters are located on each feeder, so as to show the load in each part of the district. This plant maintains its distribution and regulation thereof by balancing within itself. No feeder equalisers are here used for feeder regulation; the uniting and trying up of the system together with the use of the auxiliary bus affects this regulation. All circuits of this plant are underground, there being about 25 miles of underground conductors. These have given perfect satisfaction and reliability in their workings, maintaining to-day an insulation on the system as a whole of over half a megohm.

On the rear of the second floor are located the coal storage, water-tanks, and feed water heater. On the top floor we have the offices, supply-rooms, and workshops of the company. Returning downstairs again, we find in the basement ashpits, smoke-flues, pump-room, two large coal-storage vaults, giving a total capacity for storage of over 1,000 tons, air-blast for forced draught, and other details in connection with the steam plant.

We have, therefore, here, in a building 75ft. by 100ft., apparatus and all departments complete for the generation and supply of current of 40,000 lights, or the equivalent in light and power, and so arranged as to secure, as far as can be foreseen, continuous working of the plant and entire reliability in the supply of current. I give you now, in round figures, the cost of this plant as shown by the construction accounts and estimates:

Station building, complete, including all fittings, foundations, stacks, furniture, etc.	$100,000
Real estate	36,000
Steam plant, including engines, boilers, pumps, heaters, piping, bells, etc.	50,000
Electrical plant, including dynamos and all electrical apparatus, as switches, etc.	40,000
Underground system, material	115,000
Excavation and labour installing same	35,000
General, including lamps, meters, tools, instruments, engineering and architectural expenses, wiring, services and office furniture	50,000
Total	$426,000

This includes the entire cost for the plant as it stands to-day, which, as far as the building is concerned, is complete for the entire capacity. At present there is installed generating capacity of boilers, engines, and dynamos for one-third ($\frac{1}{3}$) of the final output of the plant. The subsidiary electrical apparatus is complete for the entire output, with a very few additions in the way of a few switches, etc. The underground lines have a capacity for 20,000 lights. The work necessary to complete the plant for its entire capacity would cost about 200,000dols. additional.

For this amount there has been obtained here a plant which is considered equal, if not superior, to any of this class, and at a cost of 20 to 30 per cent. less than has been expended for similar ones.

The next consideration is the operating expenses. To place the company on an earning basis we have to secure, to start with, a certain number of lights, or an equivalent in lights and power, to clear the necessary general and operating expenses, which will exist regardless of the smallness of the load. In other words, we must have for such a plant not less than 5,000 lights, with an average income of 8dols. per light per year to clear the general incidental and operating expenses. This figure we may consider as our unit of operating capacity. From this we can figure the increased earnings and profits for the larger number of lights connected. There exists, practically, a constant ratio of variable and fixed operating expenses. By variable expenses we mean those obtained on a variation in load and increase of business. This includes coal, oil, lamp renewals, and small increase from time to time in the amount of labour employed. The fixed expenses include those items which remain practically constant under varying conditions of income. A careful analysis of all the items covered in these expenses in such a station as this one gives the following result: That the fixed expenses are 75 per cent. of the whole, and the variable 25 per cent. approximately, or in language which may appeal more directly to you, if we double our income or business, we only increase our expenses 25 per cent. This shows that a station's possibilities and profit lie in increasing this business from the unit point.

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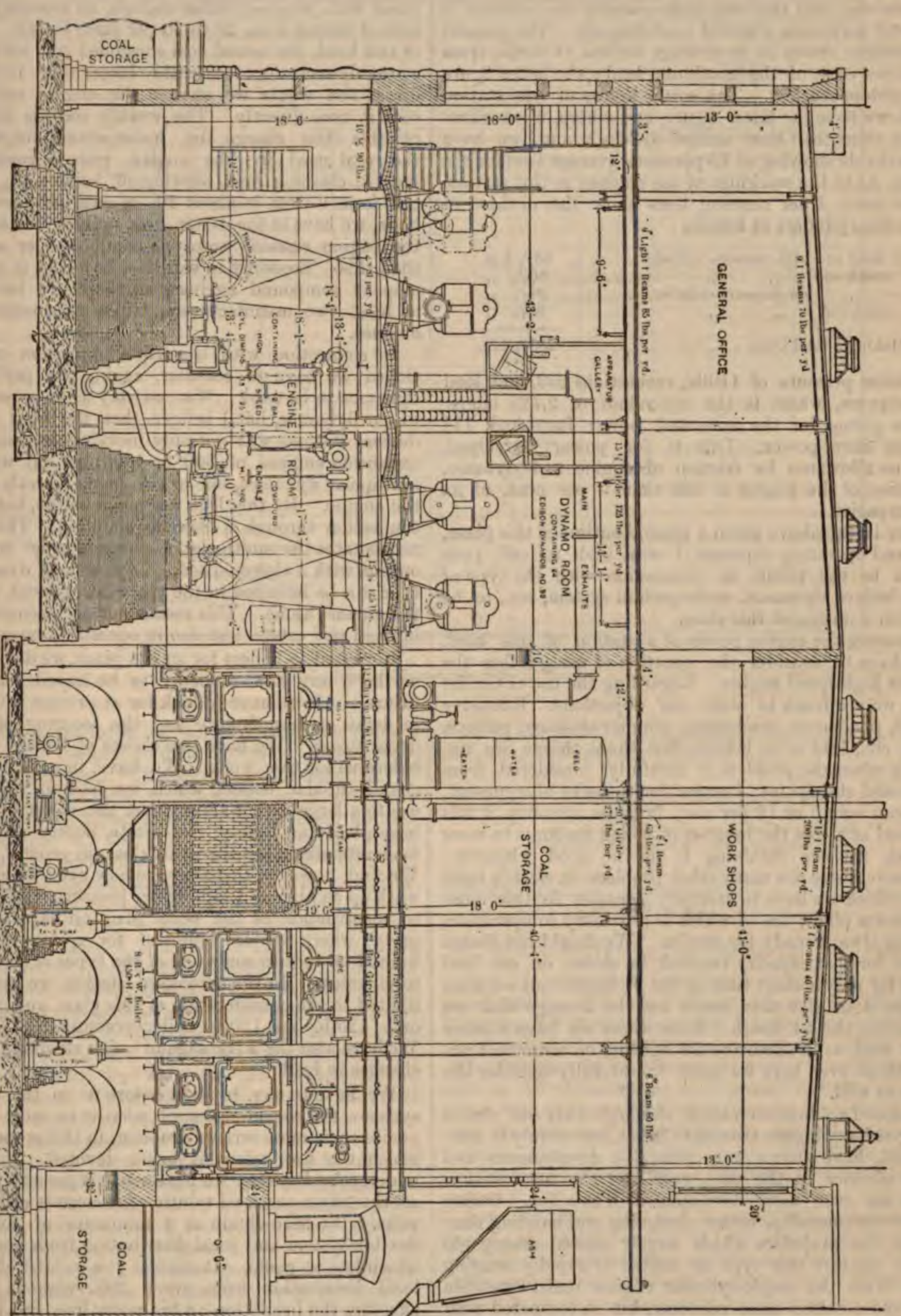
[*] From the *Electrical Engineer*, New York,

We have illustrated a load diagram taken from this station, which gives you a fair idea of the changes and variations. The maximum number of lights lighted at any time in proportion to the number connected is very good for such work, and shows a good class of business. The load diagram through the day, however, shows a new station on a clear day with a small number of lights lighted, and power work only just commencing. It is this power work that wants attention, and the securing of which means the bringing up of this average load during the daytime to a good paying basis. The curve for the evening hour indicates a good, broad, solid load, which shows the combination of six o'clock business, with the addition of a good, solid evening load. Many stations, after re



Longitudinal Section of Brooklyn Edison Station.

maximum point around six o'clock, rapidly fall off, and never regain this point again for the evening. Here we have the illustration of clubs, theatres, churches, concerts, and residences lighting after supper, bringing up the load to its maximum point between eight and nine o'clock. The average load for the 24 hours, which is about 25 per cent. of the maximum, is a very fair one, and with the addition of the day load that will come on with the addition of power, will make this a model load diagram. The general run of stations shows as an average for the 24 hours, from 20 to 40 per cent. of the maximum load; the latter figure is very seldom reached. The writer knows of one station in which we have the latter figure, and where, if we eliminate one short half-hour around 6 o'clock a.m., we have the remarkable showing of 75 per cent. average load for the 24 hours. As to the workings of the engines in this station, indicator cards from running tests show the division of work on the cylinders as follows:

I.H.P. head end high-pressure cylinder	$63\frac{3}{10}$ h.p.
,, crank end ,, ,, ...	$60\frac{2}{10}$,,
,, ,, low-pressure cylinder	$59\frac{2}{10}$,,
,, head end ,, ,, ...	$55\frac{2}{10}$,,
Making a total i.h.p.	$238\frac{4}{10}$ h.p.

with a boiler pressure of 110lb., revolutions 223, and load 1,200 amperes, which is the equivalent of 2,725 lamps, therefore giving for the indicated power furnished $11\frac{1}{2}$ lamps per horse-power. This is for power developed, making no allowance for friction of engine and dynamo. The friction of the engine is less than 5 per cent. of its normal capacity.

Having in the above given a general outline of this plant, its cost and operating expenses, I now wish to call your attention to the points in connection with the type of engines, boilers, dynamos, underground system, etc., to be adopted in a station of this class.

In planning the engine power of a station of this kind, we first have to consider the question of using either the Corliss or high-speed engine. Regarding the use of Corliss engines, we are frank to state our objections. Excessive first cost, ponderous machinery, counter-shafting, pulleys, clutches, etc., lead us to believe that these things are unnecessary when the problem is carefully considered from an unbiassed standpoint. Assume, for the sake of argument, that we can save 5 or 10 per cent. in steam economy, if this is obtained at a cost the interest of which amounts to more than this, we are obtaining it for no good whatever; furthermore, there are many other problems in electric light stations which we have to carefully consider in this question of steam plant, one of which is reliability in operation, and being always ready for service. We should not design our plant for that capacity reached as shown on our load diagram for only a short time in the 24 hours, but we must so design it to give this result for the average that we have during the 24 hours. Even where we have a more constant load, as in exclusive arc lighting on municipal circuits, I think even here we need to carefully consider the problem as well.

High-speed engines, so called, although they are not in piston speed any higher than the Corliss, but merely in rotative speed, have shown a considerable development and marked advance in the past year, and the next year is going to see even more development in this line. Owing to better workmanship, better designing and building than formerly, the prejudice which largely existed among old engineers against this type of engine is rapidly wearing away. With the single-cylinder engine under variable load we often obtain poor economy, but as compared with the Corliss, under similar conditions, allowing for the discrepancy in price, the result is not so disparaging. Now they are going further, and building compound, and even triple expansion engines of this class. In the Brooklyn station we have one of the representative types of this class of engines, horizontal compound engines.

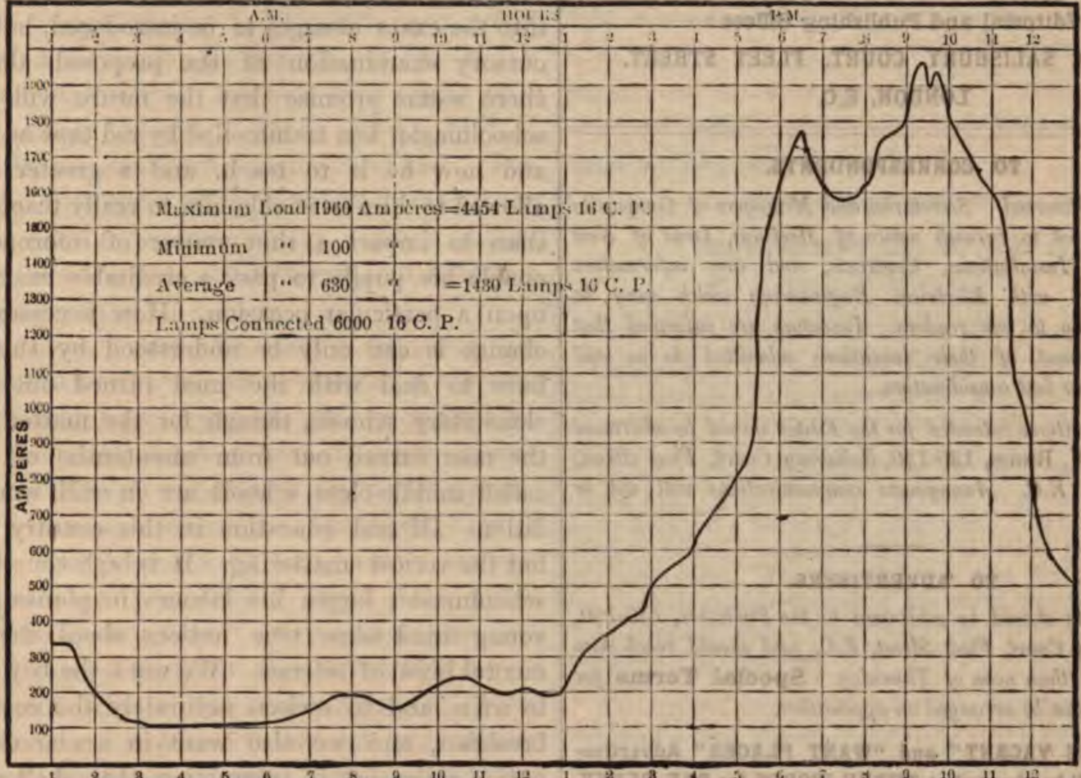
These engines are built for high economy and economical work, and the guarantees made on them, I think, compare favourably with the guarantee on compound Corliss engines. At least three or four of the manufacturers of this class of engine stand ready to-day to guarantee from 22lb. to 25lb. *of water per indicated horse-power* per hour. I do not know of any Corliss manufacturers who are willing to do any better. Engines of this class are as well built now in workmanship and as reliable in operation as can possibly be desired. Added to this, we have the advantage of direct connection to our generators. Tests made at the Brooklyn station have shown that the engines have actually come up to the guarantee made on them, and that the plant there is showing, as compared with single-cylinder engines, an economy of coal per unit of output from 25 to 30 per cent. better. In a station of this kind, the actual coal consumed per unit of output at the dynamos is considerably larger than is shown on a direct test where we charge the engine only with the coal it uses directly. The weekly records from stations of this class charge the horse-power output with all the coal used by the engine, pumps, condensers, well pumps, cleaning fires, blowing-off boilers, etc., and where the former item is about 3lb. of coal per horse-power per hour, we have in the latter case, making no allowance for the engine running empty, a result 50 per cent. greater than this. Economy in this line, however, is not going to stop at compound engines, as there are being built, by at least two manufacturers, triple expansion high-speed engines.

In connection with the triple expansion engines mentioned we have to consider, again, the problem of the dynamos to be used. We can stay as at present, and belt to our dynamos, but I believe that the next large incandescent stations will not only include compound or triple expansion engines of 300 or 400 h.p., but will also have multipolar dynamos, one or two being directly connected to the engine. By this I do not mean belted, but direct shaft connection through a flexible coupling. This, of course, necessitates the multipolar machine in order to secure the output with a slower speed. Engines and dynamos of this type can be installed in the space at present occupied by the engines alone. This means not only economy in building and real estate, but also in operating expenses.

In regard to boilers for such a plant, we do not know that we have any new economy to be hoped for in the near future. All we have to look for at present is improvement in detail of manufacture and the securing of better and dryer steam. We have two classes of boilers prominently before us for this work. We have, in general, first, horizontal tubular boilers, which we find in general factory use to a large extent throughout the country. Where we have plenty and cheap real estate, poorer attendance and moderate steam pressure, this class, in general, fills the bill. We find, however, that they are now even building them to work up as high as 125lb. boiler pressure. When we come to construction of the boiler plant on expensive city property, where we are cramped for space, we are almost limited at once to some one of the types of sectional water-tube boilers. In the Brooklyn station we are practically limited to the consideration of this class, and we have not only 125lb. but 150lb. boiler pressure, and even higher. We have also the advantage of quick steaming under heavy changes in load.

We have to-day, brought before us in the underground systems, the consideration of what is to most of the companies their most serious problem, in the proper solution of which the best talent is being devoted. In the Edison underground system we have what is generally recognised as the most practical solution for circuits of less than 500 volts. We here obtain at a minimum of cost the most flexible system and local distribution from house to house, which has no equal. It enables you to take off services for local distribution from every 20ft. without in any way affecting the insulation on the main line, and being able at any time to disconnect these services and restore the main to its original condition. In any other system we have the problem of splicing and cutting of cables, which, at its best, is bad work. What we desire is not such a high insulation, as good mechanical protection. As long as we can hold a moderate insulation with good mechanical protection, that is all we want. In Paris they have used bare copper conductors supported on porcelain in a concrete conduit. This has worked satisfactorily in the main so far, but, of course, are very expensive. They are now proposing for all their increase the Edison tubing for this class of work. In any system of cables drawn in we have the selection of a large class of conduits, but in my mind all we need and desire, as I have before stated, is mechanical protection for these cables, and the cheapest conduit that will afford this protection is all that is necessary. What is wanted especially is some system of local distribution for these higher tension circuits. The underground system installed in Brooklyn has a network of underground conductors in the mains and feeders of over 25 miles. This entire system is so arranged, distributed and connected in a network that, with a drop or resistance of 1 per cent. on the mains and 10 per cent. on the feeders, we are able to maintain in the system practically a perfect regulation in the distribution of the current. This system stands to-day representing one of the most complete and perfect examples of work of this class. The largest problems that we know of in underground work are the proposed new extension of the Edison Company in New York, and the underground system of feeders proposed to be installed for the West End Railway, of Boston. The copper alone for the latter amounts to over 1,000,000dols., and this question of the cost of the copper calls my attention to a fact which I desire to notice, that much of this question of bugbear on copper is uncalled for when we are considering the underground system. The entire copper used on the system in Brooklyn is less than one-fifth the cost of the underground system first installed.

I do not desire to claim that the ideas for the class of work here represented and described, hold or represent all the perfection to be obtained in central station work. There are many points contrary to the ideas here outlined which are very desirable; I have merely tried to call your attention to what I consider good work in this particular line, and hope that it will result in bringing forth the discussions and additions which are very beneficial in the consideration of these problems in the results to be obtained, and I would only add a tribute to the powerful and master mind whose work, from the commencement of this field of central station distribution, has covered the leading problems and points, and whose ideas to-day represent much of the good and very little of the bad problems which we have in this work. I refer to Thomas A. Edison, whose work, commencing in this field on the old Pearl-street station in New York, over eight years ago, when the majority doubted, and but few believed in its successful carrying out, and while we find that station until within the past few months, when it was partially destroyed, successfully working, and even antiquated as it was, earning large dividends. He has still continued actively to impregnate his ideas on the work from that day to this, although he has not taken such an active part in its carrying out, but I think we may see him at no distant day again taking a hand in this work, and bringing forth many new ideas in advancing the progress of the future.



Load Diagram of Brooklyn Edison Station.

CORRESPONDENCE.

PHYSIOLOGICAL EFFECTS OF CONTINUOUS AND ALTERNATING CURRENTS.

TO THE EDITOR OF THE ELECTRICAL ENGINEER.

SIR,—In your next issue you will probably publish the paper read last Thursday before the Institution of Electrical Engineers by Messrs. Harries and Lawrence, comparing the physiological effects of continuous and alternating currents.

As an example of their experiments, a continuous current of 10 milliamperes was passed through the human body without discomfort, and then the alternating current from the secondary of an induction coil (which is a discontinuous current) produced great discomfort when the instrument employed measured only two or three milliamperes.

It is only fair that the principal fallacy of their conclusions should be shown at the same time that your journal goes forth to the world disseminating the error.

The instrument employed measures the "effective" current (a kind of average over the period of an alternation). The discomfort, however, measures the *maximum* value of the current during an alternation. With a well-made alternating dynamo the maximum current is about 1½ times the effective current. But with the discontinuous secondary current obtained by breaking the primary circuit of an induction coil, the maximum current rises to many times (I estimate 20 to 50 times) the effective current. Thus the current which caused discomfort was probably 20 to 50 times the current which was measured.—Yours, etc.,

GEORGE FORBES

Westminster, S.W., March 31, 1890.

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Specimen copies of the paper will be sent on request.

HO! FOR THE SCHOOLMASTER.

The latest move in the educational world is to provide a "new code," which, if accepted by Parliament, will give rise to considerable changes in the system of teaching now in vogue in elementary schools. It is not within our province to enquire into the exact changes to be introduced, but from a cursory examination of the proposed alterations there seems promise that the future will see the schoolmaster less trammelled by red tape as to what and how he is to teach, and a greater latitude allowed to him to enable him to really teach, rather than to impart a thin veneer of information to enable his pupils to pass a creditable examination upon a particular occasion. How necessary some change is can only be understood by those who have to deal with the men turned out by our elementary schools, though for the matter of that the men turned out from nine-tenths of the so-called middle-class schools are in still worse condition. Of real education in this country there is but the veriest smattering. It is high time that the schoolmaster began his labours in planting in the young mind some true notions about the fundamental laws of science. We want the boy to read, to write, and to reckon accurately the cost of his breakfast, and we also want in a manufacturing nation some sort of instruction that shall enable a reader to ridicule such paragraphs as that which follows, and similar paragraphs which seem to delight the souls of country sub-editors. We wonder how many thousands have read the paragraph, and how great a percentage have believed, and how great a percentage have declared it to be a lie. Here is the offending paragraph, from American sources of course. No one would think of quoting it if it came from an English paper, if it was about an English discovery:

"AN ELECTRIC BLUDGEON.—Who shall say to what lengths the use of electricity will go? The latest invention connected with it, however, is anything but 'a blessing to man.' The people who will benefit by it are thieves, footpads, and other such-like gentry, and it hails from that hotbed of Anarchists, Chicago. It has already been provided with a name, too, being dubbed the 'electric bludgeon.' It is a very simple instrument—a small battery, not larger than a cigar-holder, carried with comfort and ease, supplies enough electricity to render the strongest man instantaneously insensible. To accomplish this manœuvre, all that a person meaning mischief needs to do is to supply himself with a little metal plate easily hidden in the hand, put it into communication with the battery above-mentioned by means of a conducting wire covered with some insulating substance, and touch with the plate any part of the intended victim's body. The latter will not fail to fall stunned instantaneously, and will probably die on the spot if he should happen to be suffering from heart disease. The benefits derived from the progress of science are certainly of a very mixed nature."

Of course it is unnecessary to tell our readers that from beginning to end there is no particle of truth in the paragraph. The Americans have been exercised lately about substituting electrocution for hanging. The controversy on the subject has raged furiously. But stop—perhaps the cigar-holder referred to in the paragraph is made out of Jumbo's skin, and the battery of like size is sarcastically termed a "small battery." Tyndall once got a shock from a thousand cells and did not like it. A cigar-holder the size of Jumbo's skin might hold such a battery, and give a death shock. Still, it could hardly be carried with comfort and ease. The little plate in the hand is delightful, so is the touching of any part of the victim's body. Fancy, ye men of science, that the little battery is, after all, to form a greater danger than the dynamo.

Someone said, "Give a lie a day's start and you can never catch it." No truer statement was ever made, and as this paragraph has got a good start we shall, for the next generation, hear from time to time something about this wonderful "electric bludgeon."

Some years ago when the arc light beamed brilliantly and incandescent lamps were scarcely known, there was a controversy about "the divisibility of the electric light." A question asked not infrequently now is about the divisibility of the electric light. Has it been accomplished? Here and there a local legislator makes the impossibility of dividing the electric light a text to induce his brother legislators to wait before pledging themselves in favour of the illuminant. The means at the command of the industry to combat this intense ignorance is very inadequate. There are men in every district who see the paragraphs like the one quoted, and these men should, for the general good of the industry, never let slip the opportunities of contradicting the ridiculous statements. A letter to the local paper by a local man would do more to counteract the evil than any other method. Technical papers do not circulate among the people who read this rubbish—hence have no power to dispel the illusion. How then can the busy man of business who takes a great interest in local matters know the truth about electrical matters? He reads wonderful things in his local paper, so wonderful that they are readily imprinted upon his memory, and assist in determining his position as regards electrical matters for good or for evil. It is the men who take an active part in local matters that must be convinced of the value of electric light and energy. Upon these men, to a great extent, depends the rapidity of progress.

Many of the large firms and supply companies employ canvassers to make house-to-house calls through a district where it is suggested that a central station might be successful. The tales told by these canvassers as to the knowledge, or rather as to the ignorance, of the people upon whom they chance to call would probably be disbelieved by ninety-nine per cent. of those who heard, but nevertheless many of them, probably most of them, are quite true and not exaggerated. Shopkeepers within a stone's throw, so to speak, of London Bridge have never heard of the incandescent lamp; they know about the arc lamp, and reply to the canvassers that the light is not suitable for their purposes. While such tales as the one quoted are to be found in local papers, we must expect to meet with difficulties where, if better information had been given, assistance would gladly be rendered.

PRODIGALITY IN ECONOMY.*

BY C. C. HASKINS.

(Concluded from page 256.)

Outside men, too, are often weighed in the balance, and found wanting. It is competent for an employé in electrical work to do almost irreparable mischief, and yet not be aware of the fact. There is no gauge by which his claims to knowledge and experience can be measured, except by trying him. The only way I can see to govern this difficulty is to put a thoroughly competent, reliable man over these bell-hanger and shoemaker electricians to watch and discharge them. The watchful eye of a high-priced man for foreman or superintendent has saved many a dollar to the contractor, which would otherwise have been paid after the plant was supposed to be finished, and before it was accepted.

An extraordinary demand for labour always brings to the front a class of men as unskilled as it is unscrupulous—men who never get up to their maximum of speed until about supper time. Practical electricity is suffering to-day from the wisdom of men who talk learnedly of "galvometers" and "computators," and seem to think that an insulator, like a tumbler, is most likely to be of some service when placed with the open end up. Yet the theoretical without the practical ability and education is no better. It would be poor economy indeed to depend solely on what the expert may have learned in books or at the institute. Two cases contrasted will illustrate my position.

A young man who is at present in a position of considerable importance, in addition to a small amount of education theoretically, had combined with this a practical experience in handling circuits and dynamos. A combination of circumstances, such as you all know by experience, called all the experts away from the job—which was a new plant of considerable pretensions—just as it was about ready to run. The engine was started, but soon after the lights were switched in the dynamo showed an imperfection which rendered it utterly useless. The time for the grand opening was fast approaching, and there was no other dynamo to be had there, while the factory was so far away that to get one was impossible. The trouble lay in the fact that the centrifugal force of the armature had thrown the insulation between the commutator sections out just far enough so that the brushes touched only occasionally With a very fine file he dressed down the projections, and with another tool, improvised from a second file which he ground down, he burred the edges of the sections to prevent a recurrence of the trouble, started his machine and made the opening run with perfect success, and ate his supper the next morning. That kind of a man is a jewel at any price.

A contrast of this is a case where the hero is a graduate of an eastern college, who has himself been a teacher, but he is only a book electrician. The construction of a central plant has been placed in his hands, he being the electrician of the locality, which is situated in one of the Northern States. Reasoning, apparently, that a wire which is covered with a material which the books he studied said was an insulator, that should settle the question, and, consequently, he said in effect: "No glass or porcelain can be necessary. To purchase these will cost more than staples, so we will use staples." If the fire department and the underwriters keep hands off until that plant is fully under weigh, there will possibly be some fun right near home.

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* Paper read before the Convention of the National Electric Light Association at Kansas City.

The day of dark, dingy, unhealthy, and damp dynamo-rooms, with their dangerous surroundings, is, fortunately, fast passing away. The false economy which induced the selection of such sites has become self-apparent. It has become the rule to prefer clean, light, and airy rooms, and an occasional crank on the subject has even gone to the extent of kalsomining and painting the walls, timbers, and ceiling. The great advantage, however, in the latter-day dynamo-room is the safety which comes of distance from the ground. I look upon the omission in these days of progress of any possible safeguard against danger to property or person as criminal, as contrary to the principles of true economy, and extremely impolitic. The public is not near-sighted, nor is it either tongue-tied nor weak in the lungs.

There is an expense attending the change of a circuit or the removal of one, often a no inconsiderable expense, the saving of which may not always be true economy. I refer to the common habit of allowing wires to remain after the change is made, and thus become "tramps"—homeless wires. These vagabonds, whether No. 6 underwriter, or No. 18 annunciator, are capable, like other tramps, of unlimited and incalculable mischief. It is not directly in the power of the electric light man to control the telephone and telegraph and ticker people, but he can, and should, for his own good, gather up the remnants of discontinued circuits and clear himself as far as possible from chance of blame. The public jumps at conclusions, and, right or wrong, there must be a cause given at once for every abnormal condition of affairs, every untoward circumstance, or otherwise the people's greedy appetite for sensation is unsatisfied.

It is questionable if more is not lost than gained by running incandescent lamps above their proper pressure with the idea of obtaining more light. The increased light thus obtained is indeed great proportioned to the increased pressure, but the life of the lamp is alarmingly shortened. It is better to run a volt or two below than a volt above normal pressure.

It is false economy to purchase cheap lamps, which consume more current in the production of standard candle-power, rather than to buy lamps of higher efficiency at more advanced figures. In addition to the fact that an efficient lamp is an able economic lieutenant to the coal pile, the sizes of wires needed may be less, other things equal, with an efficient lamp. And, of course, as a natural consequence, more lamps may be used to a given number of square millimetres of conductor, and more lamps can be run from the same generator.

Cheap lamps too often go upon the same circuits as the better ones, and want of uniformity of voltage throughout the plant is the natural and unfortunate result. This condition, of course, is only found on isolated plants, but it is worth considering as an argument against the peddler of inferior merchandise. Inferior lamps are poorly constructed, the candle-power and voltage are not measured by proper instruments and methods, but are guessed at by the eye, and no two consecutive lamps are similar as to candle-power under the same pressure.

In connection with this matter of lamps, a method of keeping track of lamp renewals has been shown me, which is claimed to be giving excellent results. The plant where this plan was inaugurated is one of magnificent distances—some three miles separating the extremes of the territory occupied. The company's contract with its patrons is to renew only such lamps as have burned out. All broken globes are paid for by the patrons. The company places at regular stations—usually in drug stores—a few lamps, with a blank, ruled for particulars, as to size, price, date, etc., and a receipt to the custodian, for lamps delivered. The depositaries are visited weekly, and settlements made. The advantages of this plan must be apparent to all. The consumer buys his lamps as he needs, without having either to go far, or keep a considerable number on hand, and the managers are enabled to discover a weak spot in the system if the breakage is excessive at some particular locality. This plan has been in operation something over a year, with the most satisfactory results to all parties concerned.

In conclusion, the prosecution of electrical enterprises is like that of almost any other business, and will be most successful when based on and conducted with true, proven economy, when the most approved appliances and materials are used, and the best ability in each department is employed. An incompetent fireman is a very expensive luxury, a careless lineman is a drain which saps the profit account of its treasurer, while a dynamo-man or an engineer who watches the clock more closely than he does the gauges or the brushes, is sure to be a heavy brake on the wheels of progress.

But where all the little army is striving, each individual with his own ability, to aid in the general success of the undertaking, when each feels that he possesses the confidence of his superiors, and that appreciation of his efforts is a stepping-stone to preferment, the current of success flows more evenly, the resistance which generates wasteful heat disappears, and the field of personal magnetism is strengthened and extended until it permeates the entire organisation.

GANZ ALTERNATE-CURRENT MOTOR.

A magneto-electric or alternate-current machine whose magnets are excited by direct current from another source could be used as an alternate-current motor without other preparation; but such machines must be brought to a synchronising number of turns by a force not coming from the alternate current. When this is done the speed can be retained by the introduction of the alternate current into the armature, and the speed will be preserved if the power required is not more than the motor can accomplish.

If the excitation of the magnet be made by the alternate current itself, as is the case with the alternate-current motor of Ganz and Co., then it is necessary to have a commutator rotating with the machine, so as to give to the reversals of the current the required direction. In the simplest form this commutator is made of as many segments as the armature and magnets contain coils, the alternate segments being connected together and with one end of the magnet winding, and the intermediate ones with one another and with the other end of the magnet winding, during the time the alternate current is introduced by two brushes or groups of brushes into the rotating armature. At a certain position of the brushes relative to the moment when the coils of the armature and the pole-pieces of the magnets are opposite each other, and to the synchronous speed, the magnets are excited by a current, intermittent indeed, but in the same direction.

Fig. 1 shows the Ganz alternate-current motor in perspective. The diagrams, for which, together with the description, we are indebted to the *Elektrotechnische Zeitschrift*, show the details of the connections and commutator. Fig. 2 is a diagram of the most important parts of the motor, the armature coils, A, being stationary, while the commutator, C, with the magnets, M, are rotating. The shaded portions of the commutator sections are in connection only with 1, the unshaded parts only with 2, but the brushes, B_1 B_2, are arranged in such a manner that the change of sectors takes place at the moment of passing from M to A. The alternate current is taken from the main wire for the armature as well as for the magnets, and this can be done either direct as shown in the diagram, or by means of a transformer which would reverse the proportions of current and pressure to suit the type of motor.

If the armature and the magnets are in such a position that they are just opposite each other, or if the motor is given the slightest impulse, then the motor will start by the introduction of the alternate current, and its speed will increase quickly until it arrive at synchronism. Then the alternate current will reverse itself both in the armature and magnets at every change of its own direction as long as the synchronism is maintained, so that the reciprocal effect of the pull between the magnets and armature does not change its direction, and the effects of each impulse are added together. It is therefore necessary that the iron of the field-magnets should be protected against induction currents by the well-known method of lamination. Such a motor as this, however, still leaves something to be desired.

At every reversal of the driving current powerful extra currents are induced in the magnet windings, which give rise to strong sparking at the brushes when these brushes are passing from one segment to the other, and which have the effect of making the speed unequal on account of the intensity of the fields being also unequal. Messrs. Ganz and Co. have been successful in overcoming these difficulties by short-circuiting the magnet windings a certain time before the moment of change, so that paths of small resistance are provided for the extra current excited in the magnet windings; and in this manner the intensity of the fields as a whole has a higher value. For this purpose the brushes can be placed so that at the moment of change of segments the extra induced current and the introduced current neutralise each other, and there is consequently no sparking.

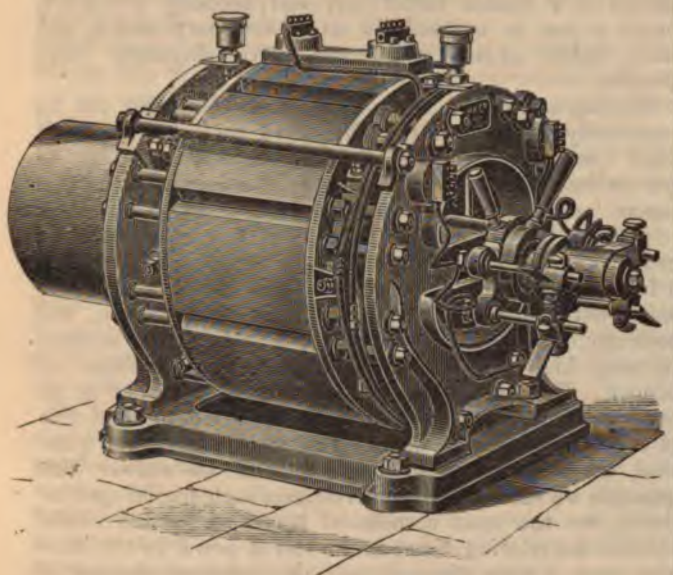

FIG. 1.

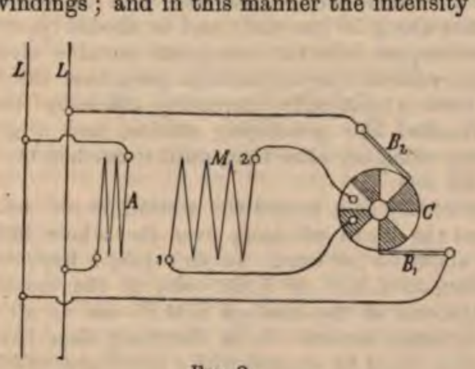

FIG. 2.

The temporary short-circuiting of the magnet windings is effected by the employment of four brushes, or groups of brushes, on the commutator, connected two and two by a wire, but so placed as to be separated from each other half or quarter the breadth of a commutator segment. In the position shown in Fig. 3, the short-circuiting of the magnet winding has just commenced, and it finishes when brush 2 leaves the dark segment.

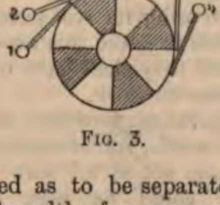

FIG. 3.

Numerous trials have shown that with a properly selected position of the pairs of brushes and with synchronous speed of the motor, sparking at the commutator is entirely obviated, and that also the motor endeavours with greater energy to keep in step with the generator. In this respect, as also with regard to the efficiency of the Ganz motor, the reports of the Frankfort Commission, now in course of publication, will give more details.

For the reason that at the described position of the brushes the starting power of the motor is not great, and particularly at small speeds, the moment of the motor is too small. Messrs. Ganz and Co., when starting, take one pair of brushes out of connection with the main wires by means of a switch, and make connection again when the motor has arrived at synchronism. Instead of switching off the brushes, they also sometimes prefer to shift the relative position of the brushes on the commutator. To prevent the current on the mains becoming too strong during the period of short circuit, a resistance is inserted in the wire between the brushes. The same effect is also sometimes produced by a transformer whose one winding is traversed by the current from the armature, and the other by the current going to the magnet coils.

ON ELECTRIC MOTORS IN GENERAL RAILWAY WORK.*

BY DR. LOUIS BELL.

The title of this paper makes it sufficiently evident that I do not intend to indulge in retrospection, except in so far as is necessary for illustration, but shall turn my attention to what is now a probability of the future.

The electric motor for street car service is an accomplished fact, as some hundreds of miles of road in daily operation bear witness. So far as practical success is concerned, the electric railroad is past the experimental stage, and is in the beginning of the commercial era. Many improvements will be made in the future, as they have been in the past, and the direction which some of the improvements have taken suggest and emphasise the probabilities I am going to discuss to-night.

First we must notice that in a large measure the running of single cars has been abandoned except on small roads and heavy grades. A good proportion of electric railroads now regularly use trailers attached to their motor cars, and sometimes trains of two or more. To meet this demand for trains rather than single cars a heavier type of motor has been introduced and even heavier ones are being projected. A powerful motor car with a couple of trailers attached cannot fail to suggest to the mind a possibility of a still more powerful car at the head of a procession of a couple of baggage cars, two or three day coaches, and as many more sleepers. Enough experiments have already been tried to show that motors nearly or quite as powerful as an ordinary locomotive can be readily made and handled. The power is in our hands, the possibility of using it on a grand scale seems nearer day by day, and we call up the aforesaid procession of cars to our minds' eye and instinctively ask ourselves: Why not?

Beside knowing the general properties of our present electric railroad, we are now in a position to make a fairly good estimate of its operating expenses. The best discussion of this which has yet appeared is the recent paper by Mr. O. T. Crosby. His results are worth the careful study of anyone interested in the particular subject now before us, and while some of his data were necessarily imperfect, they give a very good general idea of the facts.

Some recent changes in street railway practice may prove suggestive in this connection. First, we must notice the growing use of large and powerful compound-wound generators. An ordinary shunt-wound machine is ill-suited to railway service, on account of the very great variations in load, and consequently in voltage; nothing short of compound winding can or does keep the voltage reasonably constant, and the change is a most decided improvement. Besides this, the voltage in general use has been constantly rising. Less than two years ago a well-known electrician said that he did not favour the use of more than 400 volts for railway work. There are now many roads on which from 525 to 550 volts at the station is the rule, and pressures as low as 400 volts at the station are quite the exception.

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* Paper read before the Chicago Electric Club, March 17, 1890.

This increase in voltage is probably a distinct advantage. In the early days of electric railroading, a couple of years ago, the art of insulating armature and field coils was by no means as highly developed as it is now, and I think we shall soon reach the point where the voltage used for railway work will only be limited by considerations of public safety, and only, therefore, when overhead circuits of bare wire are used. It is gratifying to learn that at the Kansas City convention it was agreed to adopt, as far as possible, a uniform standard of 500 volts for railway work. We are quite certain now that 500 volts cannot be classified as a dangerous potential, at least, if the current is a continuous one; how much higher than this the limit of safety lies we do not know, though it is quite certainly below 1,000 volts. Increased voltage means increased efficiency in distribution, and increased efficiency of motors if we can secure the necessary insulation. If we are ever to use powerful motors at a long distance from the generating station, the necessity of high voltage is apparent. The possibility of using high voltages need not be questioned, for in the experiments of Deprez and the more recent experiments at Kriegsteten, potentials from 2,000 to 6,000 volts were quite successfully used. The necessity for high voltage may compel us to use Gramme armatures to secure insulation, but there is no serious obstacle.

Another recent important improvement in motor work is the very general use of carbon brushes which has facilitated the operation of railway motors in a most remarkable manner. I mention these various improvements because they apply directly to the problem we are to discuss—the transmission of large amounts of power over considerable distances to fast-running trains.

In looking at the possibility of handling large trains with motors two questions naturally arise before we can even consider the advisability of attempting it. First, can we readily build a motor to handle railroad trains at railroad speeds? To this question I think we can unhesitatingly answer "Yes." The experiments of Mr. Daft on the New York elevated road make it very clear that we can build motors large enough to do the work with every hope of success. In those experiments trains of the ordinary weight for elevated work were handled at a speed higher than that required by schedule time. Aside from this, stationary motors of equivalent size are already in use in mining operations. In fact with large motors, say from 50 to 150 h.p., we should expect to obtain rather greater efficiency than in the sizes more generally used.

We should expect, theoretically, to obtain a rather higher weight efficiency with the larger machines. In practice very many manufacturers do not increase the weight efficiency with the size of the machine. The reason for this I do not know; possibly because a machine of lower weight efficiency is sometimes cheaper to build. This question aside, there are certain advantages of a practical nature in using these large motors. When a motor becomes too large to be put under an ordinary car body, and a special motor car is constructed to hold it, it works under conditions very much more favourable to smooth and successful running, for it is far less exposed to accident and the continual small troubles arising from dirt than an ordinary street car motor. Then, too, it is possible, not being cramped for space, to arrange the whole motor outfit in such a way that it can be given close and careful attention.

The second question before mentioned is, "Can we rely on a motor with anywhere near the same feeling of certainty as on a locomotive?" A couple of years ago we should have been compelled to answer this question in the negative, but the great and rapid improvements that have been made in insulation and the various details of construction make one hesitate in giving that answer. We must remember that dynamos of corresponding size are in daily use, and frequently run months, many hours a day, without the necessity of shutting down for any purpose whatever. Given a powerful motor placed in a motor car where it can have as close attention and as watchful care as any dynamo in a central station receives, and I know of no reason why it should be subject to breakdowns, or require frequent repairs; to be sure, a motor is subjected to sudden and violent changes of load, but if well made to begin with and taken good care of, I do not think we should have good reason to fear its being unreliable. The case is not at all comparable with that of ordinary street car motors, which beside lacking even a reasonable amount of care, are subject to dirt and dampness to a degree that makes it wonderful that they do not break down oftener. A motor placed in a special motor car, and properly protected, ought to run as successfully as a stationary motor, and thus, unless grossly overloaded, give singularly little trouble.

Putting aside, then, these questions as those that can be reasonably answered in the affirmative, we come to another vital question: Can the requisite amount of power be transmitted with a tolerable degree of economy to the distances required? This question we are now in a position to answer. It is apparent, I think, at first sight that we cannot expect to distribute over very long distances without a frightful sacrifice of economy. The E.M.F.'s used are somewhat limited by the possibilities of insulation, and economy of long-distance transmission can only be secured by very high E.M.F.'s or an enormous expenditure of copper. The immediate solution of this difficulty is to operate the line in sections of reasonable length, and this of course can easily be done. This at once raises the question, what is reasonable length? And to answer this question we should have to investigate each special case in detail, for the most economical length of section would involve the relation between the loss of power in transmission over a long distance, and the increased expense of shortened sections, a ratio which evidently involves too many variables to admit of a general valuation.

Let me take for illustration a special case: Suppose we wish to deliver 100 h.p. to a distant motor, let us assume 90 per cent. efficiency for both dynamo and motor, and that we wish to transmit the power to a distance of 10 miles on either side of the generating station, using a No. 0 copper wire as a distributing conductor. We could deliver 100 h p at either end of the line, with an efficiency of somewhere about 50 per cent., and we should require about 24 tons of copper wire for a complete metallic circuit. If the motor were moving at uniform speed over the line, we should have a gradually increasing efficiency until the motor reached the generating station, and a gradually decreasing efficiency after that, until it reached the further end of the line.

The efficiency as it passed the station would be 81 per cent., and the mean efficiency over the whole line consequently about 65 per cent. In this case I have assumed, in addition, an E.M.F. of 1,200 volts at the motor terminals at the end of the line, an E.M.F. not at all impracticable for large motors. It is, therefore, clear that a 20-mile section could be worked with a fair degree of efficiency, even using a conductor no larger than No. 0 wire. Using a larger conductor, it would be possible to work a section considerably longer. I merely mention this instance to give an approximate idea of the losses of long-distance transmission, and will introduce a computation for a section of more practical length later.

A question that naturally comes up in this connection is, Whether it might not be possible to obtain the best results by means of a constant-current motor and generator. I am aware that I am trenching on dangerous ground, but unless the doors are locked before I close this paper I have hopes of escaping in the *melée*. The mechanical difficulties of keeping a long line in order for real series transmission are, I think, too formidable to make this aspect of the question worth discussing, until they shall have been effectively disposed of for short-distance work.

If we were only operating, however, one motor per section of line, in other words, transforming the system into a real block system, I am not at all sure but that the constant-current motor could be very successfully used, although its application to railroad work is as yet new.

A curious complication is introduced by the fact that if we were to operate a long line of sections, we should find, as the inspection of any time-table will show, that on certain sections no more than one train would be running at one time, while on others several trains would have to be operated simultaneously. On these last sections larger distributing conductors would be needed, and a little study of the time-table might result in a very considerable saving of copper. As the motor used would be a series motor in any case, I see no objection to working it at a constant current on one-train sections if anything were to be saved by it.

I will now consider the power which might be required and the economy that might be obtained in an actual case, taking a single section for an illustration.

The case which I am going to suppose is a transformation of the Big Four line from Chicago to Cincinnati into an electric road, so far as passenger trains are concerned. The length of the line is a trifle over 300 miles, and I shall suppose it to be divided into some 10 or 12 sections, each with a power station at its middle point. This arrangement of the power stations evidently will secure the greatest average economy. The road is a single track one, and the hypothetical section which I shall investigate is the section between Kankakee and Sheldon, Indiana, a distance of 30 miles. I take a case of this sort to show what will be the actual power required and the proximate economy in case of an actual railroad running its regular trains on its present schedule time.

In looking over any time-table, it will be noticed that any such given section will only require power at certain hours of the day, and a varying amount, according as one or more trains may be operated at the same time. Having worked out the times for supplying power and the probable amount, I shall then investigate the probable economy of an hypothetical electrical equipment.

Looking over the time-table of the Big Four line, between Kankakee and Sheldon, it appears that passenger trains are on that section during the following hours: 11.25 a.m. to 12.35, 1.40 to 3.10, 10.25 to 11.32 p.m., and again in the early morning from 3.20 to 4.30. From 1.40 to 3.10 two trains are simultaneously upon the section; at all other times only one train would have to be operated at a time. Looking further, we should find that by changing the time of two local trains from Kankakee to Sheldon, which do not connect with anything, and by changing that time only a few minutes, it would never be necessary to operate more than one train on the section at a time. Making these changes, the hour of supplying power would be 10.25 a.m. to 3.10 p.m., 10.25 to 11.32 p.m., 3.20 to 4.30 a.m. The problem then resolves itself into supplying power enough to operate an ordinary train at the usual speed, and at a maximum distance of 15 miles from the power station.

Let us now suppose the motor to work at 1,500 volts at its terminals at the end of the section. The power required to operate the train would be about 200-250 h.p. at the average speed, consequently the current transmitted over the line would be 100-125 amperes.

Of course, we might suppose any number of hypothetical line equipments, but I shall confine myself to one in which the amount of copper required will not be specially forbidding. I shall suppose a line wire No. 0, connected at short intervals to a bare trolly wire of silicon bronze, or some similar alloy. The conductivity of this system is more than equivalent to a single wire No. 000, on which I should base my calculation. I should suppose track and ground systems to be made in the ordinary way. The length of conductor on each side of the central station would be about 79,000ft., and the fall of potential for 100 amperes over this distance would be a little over 500 volts, the generator, therefore, would have to develop a little over 2,000 volts, and the line efficiency at the terminals of the section would probably be somewhere near 75 per cent. The average line efficiency for the entire section would probably be somewhere near 85 per cent. The total amount of copper required for the section would be about 110,000lb., including insulation, or about 3,600lb. of copper per mile.

With, therefore, this amount of copper, which seems not at all excessive, we should have an average line efficiency of about 85 per cent. Now assume a commercial efficiency of the generator of 90 per cent., and assume for the efficiency of the motors and gears 80 per cent., which for motors running at high speed and with infrequent stops, does not seem an excessive estimate, the mean commercial efficiency of the combination would be a little above 60 per cent. In other words, taking into account all sources of loss, we should probably have an efficiency of a little over 50 per cent. from the indicated horse-power at the engine, to the power supplies at the axles of the car.

Now let us look a little further and see the amount of power which would have to be supplied to the section which we have been considering. Looking over the time-schedule we see that power is required for almost exactly seven hours, and to supply the 200 h.p. necessary at the train, we should have to furnish about 400 h.p. indicated at the power station. We should, therefore, furnish 2,800 h.p. hours to the section under consideration, and we should have the advantage of being able to use compound condensing engines. These engines ought to be able to furnish the indicated horse-power hour on two pounds of coal, the coal required for our supposed section then would be 5,600lb. for the 24 hours. Banking fires between runs would consume some little coal beside, but with proper engines and good firing the 2,800 h.p. hours ought to be furnished on three tons of coal. For express speeds, of course, 200 h.p. would be too small and coal consumption would be larger, while the line efficiency would be slightly lower. Still, in our supposed case we would count on a mean efficiency of 50 per cent. from indicated horse-power to train, for while fast trains would entail greater loss in the line, the average figure would not be seriously lowered. This amount is probably a trifle less than would be required by the locomotives doing the same work. Seven to eight pounds of coal per car, which is a fair estimate for passenger trains, and as we may take the trains to average five cars, the amount required on the section per train would be from 1,000lb. to 1,200lb., or for the six daily trains probably 7,000lb. There would probably be, even in this extreme case, a slight saving of fuel.

We are now in a position to form a tolerably clear idea of the probable cost of equipping such a section as we have been discussing. We shall require for equipment a 400 h.p. compounding condensing engine and dynamos to match; then we shall require, as before mentioned, a little less than two tons of copper per mile. In return for the investment in these items, we get an average commercial efficiency of a little over 50 per cent., and the question to be raised is the exceedingly practical one, will it pay? We gain the advantages of being able to use a very economical engine, and of being able to dispense with a certain number of employés. To make these gains we content ourselves with an efficiency of 50 per cent.

It is worth noting, too, that the mean efficiency of such a section cannot be raised to a very high figure, for the reason that even with the small amount of copper specified most of the loss is in the double transformation affected by dynamos and motors, and not in the line.

If the amount of copper were doubled, we should still have to be content with a total commercial efficiency of about 60 per cent.

In Mr. Sprague's very able paper, read before the National Electric Light Association, he has pointed out the economy secured by multiplying power stations and using shorter sections. The practical way to put the question of economy to be thus secured is this: "Will it pay to double the expenses for power stations to save three-quarters of the outlay on copper, or will it pay to double the cost of power stations for the sake of saving the above proportion of the power lost in the line?" This view is necessarily somewhat limited, for in the case of compact systems the saving can be effected without anything like doubling the cost of power stations. Without going into detailed estimate it would seem doubtful whether there would be much practical economy in an extensive system of power stations. The three-wire system suggested by Mr. Sprague in the same paper is a much more practical way of securing economy, and may come into extensive use. On a double track road, such as we have in suburban or elevated roads, this three-wire system could be operated to very great advantage.

Let us now look at the locomotive a little for the purpose of seeing whether we are going to gain enough in saving coal and wages to pay for 40 or 50 per cent. energy lost in the various transformations of the electric system.

There seems to be a widespread popular delusion to the effect that the locomotive is an exceedingly uneconomical machine. On the contrary, the figures of actual tests show that the locomotive compares very favourably with ordinary non-condensing engines of similar size. Several locomotive tests made in New England a few years since gave the horse-power hour on between four and five pounds of coal, or with the evaporation of less than 30lb. of water. Figures obtained with the Strong locomotive show even better results, some of the runs being made on less than 4lb. of coal per indicated horse-power, and the average result being most remarkable.

Various foreign experiments point in the same direction to show that a well-cared-for locomotive will give the horse-power hour on 27lb. to 30lb. of water. Even the small engines on the New York elevated road, working as they do with an average horse-power of only 38 per cent. of the maximum, still consume only $6\frac{2}{10}$lb. of coal per horse-power hour; and no engine could be put to more trying service, for nearly 60 per cent. of the power used on a round trip is used in getting up headway at stations.

(To be continued.)

ALTERNATING v. CONTINUOUS CURRENTS IN RELATION TO THE HUMAN BODY.*

BY H. NEWMAN LAWRENCE, MEMBER, AND ARTHUR HARRIES, M.D.

Much attention has lately been drawn, both in England and America, but especially in the latter country, to the dangers to which workmen and others are exposed when handling and working with wires, dynamos, and other apparatus connected with the generation and supply of electric currents for light and power.

A lively controversy regarding the relative safety of continuous or alternating currents has resulted; but little, if anything, has been done to throw direct light upon the matter, and great difficulty is therefore experienced by disinterested persons in arriving at a satisfactory conclusion.

It is with great diffidence that we venture to offer this short paper on the subject, as the experiments and observations upon which our contribution is based were not specially undertaken with the object of throwing light upon it. They form part of a series of data connected with investigations upon which we are engaged with the hope of solving some of the physiological problems occurring in the course of our electro-therapeutic work at the Institute of Medical Electricity.

The results obtained from some of our experiments (hereinafter given in detail) led us to note how strongly they bore on the question now before us. We therefore, after verifying them by repetition, thought it well to invite discussion upon them, and now offer them for your consideration, with full consciousness of their imperfection. They differ from the experiments of D'Arsonval, Harold P. Browne, and others, in the important point that they deal, not with the bodies of rabbits, dogs, and horses, or other animals (from which conclusions regarding human life have to be evolved), but directly with the human body.

We do not in any way propose to touch upon the question of the manner in which accidents with electric wires, etc., occur, or how they may be prevented. It would be manifestly beyond our province to do so. Our object is rather to compare the physiological action of the two forms of current *after the contact*, accidental or otherwise, has been made, and to arrive at some conclusion as to the danger-ratio which one form of current may bear to the other under such conditions.

As may already have been gleaned, our experiments have not been made with the powerful currents dealt with in electric lighting and distribution of power. We have used small currents, for the most at low E.M.F., and have directed our attention to (1) the determination of the resistance of the human body and skin to the passage of currents under certain conditions; and (2) a comparison of the sensations produced in the human body by passage of the two forms of current.

1. With regard to the resistance of the human body and skin. In his Lumleian Lectures delivered before the Royal College of Physicians in April, 1886, Dr. W. H. Stone gave some very useful information. His experiments appear to have been carried out with care, and the results, therefore, are reliable. In the course of many similar experiments we find no reason to differ in the main from the figures he has arrived at, and we quote those that refer to our immediate subject in the following table:

TABLE A.

	Resistance, Foot to Foot.		Resistance, Foot to Hand.
Mr. T.	945 ohms.	....	1,320 ohms.
Mr. S.	930 ,,	....	1,027 ,,
Hungarian Giant	930 ,,	....	1,032 ,,

There is, however, this important fact to be taken into account when considering the bearing which these figures have on the present question, viz., that Dr. Stone, having a direct therapeutic object in view, was dealing, as far as he could, with the internal resistance of the body, and not with its total resistance as represented by that of internal tissues and skin in its normal insulating condition.

Further, Dr. Stone's experiments were scarcely typical of results to be expected from either purely continuous or purely alternating currents, for in his lecture he says, with reference to the experiments quoted in Table A, that he had in "circuit a Wheatstone bridge of a rather particular form, a commutating key so as to send the current in opposite directions, etc."

Some experiments conducted by Mr. Wm. Lant Carpenter, however, are more in accordance with the conditions which this paper is intended to illustrate, as they enable us to form some clear idea of the nature of the current actually used.

The results of these experiments, published in August, September, and October, 1883, in *Health*, are shown in

TABLE B.—Continuous Currents.

	Resistance from Foot to Foot in Ohms.			Resistance from Foot to Foot in Ohms.	
Dry Skin	— min	10,300	Salt and water ...	30 min.	1,400
Salt and water	1 ,,	4,300	,, ,, ...	35 ,,	1,290
,, ,,	5 ,,	2,500	,, ,, ...	40 ,,	1,250
,, ,,	7 ,,	2,100	,, ,, ...	45 ,,	1,230
,, ,,	10 ,,	1,900	,, ,, ...	50 ,,	1,200
,, ,,	15 ,,	1,720	,, ,, ...	60 ,,	1,190 to 1,200
,, ,,	20 ,,	1,540			
,, ,,	25 ,,	1,470			

Our own experiments have been made with the skin normally dry and moist, and we have selected measurements taken from hand to hand, as the hands are the parts most likely to come into contact with wires and other conductors.

The first series of readings are those of resistance to continuous current. They were taken by the ordinary Wheatstone bridge method with a mirror galvanometer. Tin electrodes, each of 50 sq. cm. area, were used, the extended palms being placed upon the electrodes.

The results are shown in

TABLE C.—Resistance to Continuous Currents.

Subject.	Age about.	Dry.	Moist with Distilled Water.	Moist with Salt Water.
	Years.	Ohms.	Ohms.	Ohms.
1	35	39,000	19,700	9,170
2	22	49,000	7,700	5,900
3	35	41,400	23,000	11,000
4	38	40,000	11,500	5,900
5	35	50,000	9,500	5,000
6	40	45,000	30,400	26,400
7	21	19,000	7,600	6,700
8	22	27,000	25,400	12,000
9	26	31,000	7,000	6,500
10	24	40,000	10,700	7,000

In estimating the measurement of resistance to the continuous current, we must remember that, as the result of the almost instantaneous congestion which follows the closing of the circuit, resistance is to a certain extent diminished.

Very shortly this is succeeded by polarisation, and by the conditions which accompany the conversion of the body into a secondary battery, and there is consequently a considerable increase in resistance when the passage of current is continued for an appreciable time.

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* Paper read before the Institution of Electrical Engineers, March 27th, 1890.

On the other hand, the passage of alternating currents is accompanied by a diminishing resistance from the outset, for the early physiological congestion is followed neither by polarisation nor by the electrolytic action which it is usual to expect when the continuous current is used.

Table D shows the resistance to alternating currents of the same ten people taken with the same electrodes on the same occasion as those referred to in Table C.

TABLE D.—Alternating Currents.

Subject.	Dry.	Moist with Distilled Water.	Moist with Salt Water.
	Ohms.	Ohms.	Ohms.
1	2,900	2,500	1,500
2	10,400	1,800	1,200
3	5,500	1,600	1,600
4	2.500	2,200	1,200
5	5,400	1,600	1,500
6	2,600	1,700	1,300
7	1,400	1,450	1,250
8	2,350	1,500	1,400
9	3,500	1,500	1,600
10	5,000	1,375	1,500

Tables C and D are fairly comparable as regards the same individuals, though the maximal differences are strongly marked.

Dr. Stone, in his lecture above referred to, mentioned a very important fact, which since appears to have been overlooked—viz., that (under the conditions he adopted) the resistance of the human body was only about half as great for alternating currents as for the continuous current. This statement we have never seen questioned, and our own experiments show that under conditions more assimilating to those likely to occur in practical work, the proportion is considerably greater. Table D shows wide variations in the resistance of the individual tested, as well as other peculiarities which are no doubt partly due to errors of observation, but more largely due to physiological conditions which are scarcely relevant to this paper; but the tremendous difference between the resistance to alternating currents and the resistance to the continuous current is clearly and definitely marked, and justifies us in drawing certain conclusions therefrom. We find the—

	Ohms.
Average resistance to the continuous current, moist with salt and water,	9,557
,, ,, ,, alternating ,, ,, ,, ,, ,,	1,405
,, ,, ,, continuous ,, ,, ,, distilled water,	15,250
,, ,, ,, alternating ,, ,, ,, ,, ,,	1,722
,, ,, ,, continuous ,, dry ,, ...	38,140
,, ,, ,, alternating ,, ,, ,, ...	4,155

This difference was illustrated in a comparative-resistance diagram.

When this condition of things became apparent we thought it well to confirm our experiments by repeating them as far as possible under conditions such as would occur in actual working.

The results of this set of control experiments we give in Table E. The ten persons tested were chosen so as to be, as far as possible, representatives of those likely to come in contact with electric light and power wires and other conductors. Five were workmen with hands hardened, and rendered by toil, as far as may be, insensitive to electric currents. The other five were men accustomed to brain work, and may be taken as representing the occupiers of houses likely to use the electric light, and occasionally to come into contact with the leads, terminals, lamps, etc., of house installations.

The electrodes used were of plain metal, and could be grasped in the hand, and so may be taken to represent the metal about a dynamo, or a bare wire or other conductor, which might be grasped accidentally by a workman occupied about a lighting or power station, or by a gentleman investigating some electrical irregularity in his own house.

The continuous-current tests were made with a Wheatstone bridge of Post Office pattern, and a mirror galvanometer. The alternating-current tests were made with one of Kohlrausch's rheometers, in which the balance is observed through a telephone. The alternating currents obtained from the induction coil of the instrument had a periodic frequency of about 300 per second.

The dry readings were taken with normally dry hands The moist readings were taken after the hands had been dipped into ordinary tap water.

TABLE E.

Subject.	Resistance in Ohms.			
	Dry Hands.		Moistened Hands.	
	C.C.	A.C.	C.C.	A.C.
1	36,000	2,200	25,000	1,450
2	17,000	1,850	9,000	1,400
3	7,000	1,800	6,400	1,600
4	12,000	1,400	5,900	1,275
5	18,900	1,600	14,700	1,450
6	8,400	1,450	3,900	1,200
7	10,450	1,000	7,500	1,300
8	8,500	1,500	7,300	1,450
9	14,300	2,000	10,900	1,600
10	12,200	1,900	6,900	1,650
Average...	14,475	1,740	9,750	1,437

These results indicate that the resistance of the human body to continuous current is 6·8 times greater than it is to alternating currents when the skin is moistened, and 8·3 times greater when the skin is in its normal condition and not moistened by artificial means.

Starting with the statement of Dr. Stone, that when the skin has been well soaked with a conducting fluid, and electrodes of large area are used, so that little, if any, more than the internal resistance of the body comes under observation, the resistance to the continuous current is nearly double that to alternating currents (*Electrical Review*, May 7, 1886, p. 417), we find that the ratio increases conversely with the moisture of the skin, till in the normal condition we reach the maximum of 9·1 for contact of small area, and 8·3 for contact obtained under ordinary working conditions.

We now come to the second part of our subject—viz., a comparison of the sensations produced in the body by the passage of the two forms of current.

The sensitiveness of persons to the continuous current varies very much, quite independently of variation of resistance. But we find that most people (and we have tested some hundreds) can bear without discomfort the passage of 10 milliamperes for a short time, and therefore for the purposes of this paper we will consider that amount of current-strength as the maximum which may be passed through the body without producing unpleasant sensations.

With alternating currents, however, a very different state of things is disclosed; for having in the course of our therapeutic work found the great need for accurately measuring the alternating currents from induction coils, we obtained from Germany (after failing to find a suitable instrument of English make) a galvanometer recording milliamperes of alternating currents, and on putting it in circuit with a patient, were surprised to note that before the needle indicated the passage of a single milliampere the patient complained that the current was too strong, and practically unbearable.

This, of course, led to further investigation, with the result that, though we tested a large number of persons of varied age and of both sexes, we found only a few who could bear with comfort the passage of one milliampere of alternating currents.

Table F shows the result of sensation tests made upon the ten subjects above referred to.

TABLE F.—Sensation Tests.

Subject.	Without Discomfort.		Muscular Fixation.
	C.C.	A.C.	A.C.
	Ma.	Ma.	Ma.
1	10·0	2·0	4·5
2	10·0	2·0	3·0
3	10·0	2·5	3·75
4	10·0	1·0	2·75
5	10·0	1·0	2·0
6	10·0	2·0	3·25
7	10·0	2·5	6·0
8	10·0	2·0	4·5
9	10·0	1·0	2·25
10	10·0	1·0	4·0
Average	10·0	1·7	3·6

[Experimental sensation tests were here shown.]

So far we seem to be justified in putting the limit for alternating currents at two milliamperes, and we wish it to be understood that any advance upon this limit means extreme discomfort. Beyond that point violent muscular contraction, rendering relaxation of grasp first difficult, and then impossible, produces distinct pain, which agitates the whole body.

We can therefore confidently state that, as far as sensations are concerned, the human body can bear with ease at least five times as much of continuous-current strength as of alternating-current strength. When this fact is taken in connection with the great difference in the resistance offered by the body to the two forms of current, it leads to the conclusion that the danger of unpleasant consequences, and possibly (if not probably) of loss of life, when currents of equal voltage are handled, is 34 times ($6·8 \times 5$) greater with moist hands, and 41·5 times ($8·3 \times 5$) greater with dry hands, when alternating currents are used than when the continuous current is employed. These figures we will adopt as representing the danger-ratio.

As a practical example of this conclusion we may take the Board of Trade limit of pressure at which currents may enter houses, viz., 200 volts, and assume that a man having the average resistance taken from Table E handles naked wires within the house.

$$\left.\begin{array}{l}\text{With the continuous}\\ \text{current (dry hands)}\end{array}\right\} C = \frac{200}{14{,}475} = 13·5 \text{ milliamperes.}$$

He thus receives only 13·5 milliamperes, which is little more than, as shown above, he can take with perfect impunity.

$$\left.\begin{array}{c}\text{With alternating currents}\\ \text{(dry hands)}\end{array}\right\} C = \frac{200}{1{,}740} = 115 \text{ milliamperes.}$$

He thus receives 57 times more current than he can bear without discomfort, and the danger of physiological shock is correspondingly increased.

This danger-ratio was illustrated diagrammatically. It may be objected that all this has little relevancy when large currents, of either kind at high potentials, have to be dealt with; but we would submit that what we have proved to be the case with small currents and low potentials may be fairly taken to be intensified as the current-strength and E.M.F. increase. There is at present no reason to suppose that the ratio of resistance diminishes, or that of the sensations becomes lessened, though it may possibly happen that with increased current-strength or higher potential the absolute resistance may vary.

What the minimum current of either kind which will destroy human life may be, we are not in a position to say; though D'Arsonval, in his report on electro-physiology made before the International Congress of Electricians held at Paris, 1889, says, referring to his experiments on rabbits, guinea pigs, and dogs: "With a machine of 8,000 volts a momentary closing of the current caused the animal (a rabbit) to make a prodigious leap, but did not cause death immediately; a second application was necessary."

"An alternating Gramme machine only causes death above 120 volts mean potential."

These statements are not very clear, but we gather therefrom that while a continuous-current machine having an E.M.F. of 8,000 volts did not instantly kill a rabbit, yet an alternating-current machine having a mean potential of 120 volts did. We feel sure that no hard and fast lines can be laid down on the subject. Individual resistance and individual sensitiveness vary so much and so unexpectedly that a current which might be taken with impunity by one person, might be more than enough to kill another.

With regard to danger-ratio, D'Arsonval seems to more than bear out the conclusions that we have arrived at, though he gives no information as to the current-strength used.

Independently of the kind of current used, the character of the contact made, the surface area of the body involved, and the suddenness of closing or opening the circuit must each and all play an important part in the result.

Shock varies with the form of current employed: thus with continuous current only a "make" initial shock is possible, while with alternating currents the initial shock may be either a "make" or a "break" shock.

As "break" shock is admitted to be the more marked of the two, independently of the steady diminution of resistance to alternating current, it is probable that the effects of an initial shock with alternating currents of similar strength may be more disastrous than that with continuous current.

DISCUSSION.—*Authorised Abstract.*

Prof. Forbes said that although the comparisons of the effects of alternating and continuous current were very interesting, the tests made and the results obtained had little bearing on the practical question of safety in the use of electricity for lighting and power purposes, for the conclusions arrived at in the paper are not in accord with actual experience. He was willing to admit that he could not bear so many volts alternating as continuous, but the difference was comparatively small, certainly nothing like so great as the authors would have him believe. The sensations, he said, depend not on the mean current, but on the maximum value of the current or volts; and in the case of an induction coil, the volts on break were immensely greater (20 to 50 times) than the maximum occurring in a well-designed alternator, which would send the same mean current through the body as that indicated by the measuring instrument used.

Mr. Kapp concurred in Prof. Forbes's views as to the great difference existing between the conditions under which the experiments were made, and those occurring in practice as regards alternating currents. From experiments he had tried himself, he found he could bear 100 volts continuous with about the same discomfort as 40 volts alternating.

Major Cardew agreed with Prof. Forbes's statement about the much greater maxima obtained with induction coils than with alternating machines, and said that great differences exist in the shocks received from different machines, even when the measured volts were the same. For example, shocks received from old Wilde machines were very severe, even when the volts were small; he had known a man to be nearly killed by a 300-volt machine of that type, whilst from a modern alternator 100 volts may be taken without great discomfort. Speaking of resistance tests in Table E, he remarked on the great differences in the resistance of individuals to alternating and continuous currents, and on the disproportionality between them; these differences, he believed, were due to polarisation of the electrolytes in the body. As regards sensation, he had reason to think that the effect of a given current depends on the volts employed to send the current. Referring to the Board of Trade regulations, he informed the authors that permission to use 200 volts alternating on consumers' circuits had never been granted.

Dr. Stevenson agreed with the last speaker as to the current from a large battery producing more powerful sensations than an equal current from a smaller number of cells.

Mr. Sayers thought sensation depends greatly on the shape of the E.M.F. curve and on the frequency of alternation.

Mr. Wyles said he once saw a man come into contact with a Brush 35-lighter; fortunately he fell away from the machine, and the only after effect was a pain across the chest.

Mr. E. T. Carter asked whether the resistances to continuous currents were all obtained with the same current strength, or whether various strengths were used in each case, for if there was polarisation, resistance would vary with current? He also enquired if the effects of purely transient currents, such as discharge from cables, and of electrostatic capacity, had been investigated, and asked what was the effect of alternating currents of frequencies less than 300 per second.

Mr. Crompton said he had recently tested the resistances of individuals by Evershed's ohmmeter, 100 volts being used in all cases. As a rule he found the resistance to fall from 30,000 or 40,000 to 25,000 by continued application, and in some cases 10,000 or 11,000 ohms were indicated. Children usually gave 8,000 to 10,000. One person whose wrist had recently been subjected to a surgical operation gave a resistance of 25,000 from hand to hand, but on placing one electrode on the part operated on the resistance fell to 14,000. The sensation effects varied greatly in different individuals, for some whose resistances were 30,000 experienced much greater discomfort than children with 10,000 ohms resistance. As to alternating currents, he believed that there was a general concensus of opinion that only about half as many alternating as direct volts could be borne. Some time ago he, in conjunction with Colonel Armstrong, had made experiments to see what current one could bear, and they found that at 15 milliamperes the skin below the electrodes became hot, whilst at 35 milliamperes the skin was scorched in a few seconds.

Mr. F. H. Nalder suggested that the differences between the resistances with wet and dry hands might be due to surface leakage.

Mr. Joyce said that even if we admit the difference in the E.M.F. curves of induction coils and alternators in producing sensations as pointed out by Prof. Forbes, yet from Table E one can see that there is a great difference between the resistances of the body to alternating and continuous currents. This, of itself, means a serious difference in the "danger-ratio."

Mr. W. H. Preece believed there had been more nonsense talked about this subject, particularly on the other side of the Atlantic, than on any other with which he was acquainted, and they were indebted to the authors for clearing the ground a little. He himself had had the misfortune to receive the discharge from a Leyden jar, and to be transfixed to a 2,000-volt Brush machine. He was also in the habit of receiving shocks from continuous currents of about 25 milliamperes without experiencing as much unpleasantness as he had just felt with a current of two milliamperes from the induction coil. This led him to enquire whether the instrument used to measure the latter current was accurate. Quite recently he had received an account of an accident, whereby a man was subjected to a shock from a 1,200-volt circuit ; his fingers were burned and he was rendered insensible for ten minutes. Speaking of the so-called "dangers of electricity," he said the difficulty was to kill, rather than to prevent being killed, and that the question was not one of high or low potentials or alternating *v.* continuous currents, but of overhead *v.* underground mains, and bad or good workmanship and insulation. In his opinion it should be impossible for anyone to accidentally come into contact with house circuits.

Dr. Harries said he had anticipated more discussion on the physiological points raised. Referring to Prof. Forbes's views, he remarked that the high voltage on breaks means little if the resistance be high. In reply to Major Cardew, he said the differences in resistance depend entirely on the normal state of the skin, and that polarisation does not play an important part, for in the continuous-current experiments the contacts were instantaneous. As regards the effect of frequency, he stated that the greater the frequency the less unpleasant a given current becomes. Mr. Crompton's results in the main confirmed their own, but had thrown doubt on the polarisation effect. However, Dr. Stone had shown that it existed, and the first fall of resistance is accounted for by the congestion of the part touched.

Mr. Lawrence, replying to the electrical points, said the frequency of the alternating currents was about the same in all the experiments, and that from greater frequencies he would expect less effect. As to the accuracy of the milliampere-meter, he said he would be glad to have it tested by anyone interested. They themselves had had it tried by an experienced firm, who reported it to be within 5 per cent.

Mr. Alex. Siemens (who was in the chair), in proposing a vote of thanks to the authors, said they had heard a great deal about the dangers of electricity, but nothing about its beneficial applications. He himself had experienced its pain-alleviating properties in the case of teeth extraction. The positive terminal of a battery was held in the hand and the negative attached to the forceps, and the pain was very slight compared to that experienced in the ordinary method of extraction. The effect he believed was due to the nerve being cauterised by the current, and he suggested to medical men the question whether some such method could be adopted with advantage in amputations and other surgical operations.

LAMBETH.

A special meeting of the Lambeth Vestry was held on Thursday last, the Hon. and Rev. Canon Pelham in the chair, to consider a motion, which was moved by Mr. Philpot, in reference to the electric lighting of the parish. The motion was as follows : "That the consent of the Vestry be given to the application of the House-to-House Electric Light Supply Company, Limited, for a provisional order under the Electric Lighting Acts, such order to extend to the whole of the parish, except that part set out in the area of supply set out in the first schedule to the London Electric Supply Corporation Electric Lighting Order, 1889, and except that part of the parish included in the area of supply set out in the first schedule to the draft order now applied for by the Electric Lighting Installation and Maintenance Company, Limited."

Mr. Andrew asked what was the time in which the company would have to complete the work?

The **Clerk** (Mr. H. J. Smith) : Two years from the date of the order.

Mr. Davidson said the parish of St. Pancras had determined to keep the matter in their own hands, and to carry out electric lighting in such a way that the ratepayers would benefit thereby. He thought they would be making a great error if they allowed the matter to slip out of their hands, and he moved, as an amendment, "That the Vestry oppose the order, and that the Electric Lighting Committee be instructed to consider the desirability of the Vestry applying for an order for the carrying out of the work themselves."

Mr. Osborne seconded, and said he considered that if there was any money to be made out of electric lighting, the ratepayers should have the benefit of it.

Mr. Fawcett supported the amendment, as did also **Mr. Greaves**, who thought it would be wise to reconsider the matter.

Mr. Shapley did not think there would be much hope of getting electricity if it were left in the hands of the parish.

Mr. Aldir supported the motion, but **Mr. Pritchard** thought they would be making a great mistake if they allowed the matter to pass out of their own hands.

Mr. White asked how a long a time the company's privileges would extend over?

The **Clerk** : Forty-two years.

Mr. White said that was a long time. He certainly thought the Vestry ought to pause before surrendering such a privilege.

Mr. Wightman supported the motion, **Mr. Hooper** the amendment, whilst **Mr. Chambers** opposed it.

The **Rev. W. A. Morriss** said he certainly was of opinion that the Vestry should keep the power in their own hands, even if they did not use it.

Mr. Baygrave gave it as his opinion that the Vestry should retain the power rather than hand it over to a company.

Dr. Crossman thought that the matter should be allowed to stand over to be dealt with by the new district councils.

In answer to Councillor Bell, the **Clerk** said the Board of Trade had the power to make an order over the heads of the local authority. If the Vestry expressed their readiness to do the work, he did not think the Board of Trade would give an order to any company, but he did not think the Board would allow any Vestry to play the part of dog in the manger.

The motion received the support of the principal members of the Vestry, and, upon a vote being taken, the amendment was rejected by 40 votes to 15, and the motion agreed to.

COMPANIES' MEETINGS.

LONDON ELECTRIC SUPPLY COMPANY, LIMITED.

The third ordinary general meeting of this Company was held on Monday at the City Terminus Hotel, under the presidency of Mr. J. S. Forbes.

The **Chairman** referred with great regret to the resignation, mainly for reasons of health, of the Earl of Crawford, who until recently had presided over the Company. As the works were now approaching completion, and the Company was likely to develop at no distant time into a working undertaking, his (the speaker's) colleagues had thought that he might be of some service to them by taking the post previously occupied by Lord Crawford. The accounts were presented upon the model required to be made by the Board of Trade, and he thought that they rested upon this possibility—that in accordance with the conditions on which this and similar companies had come into existence there might be a time when some other interest—local authority or otherwise—might acquire the right of taking over the enterprise upon certain terms set forth in the concession, charter, or provisional orders belonging to them. The Company were authorised by their articles to raise £1,000,000, divided into 200,000 shares of £5 each, of which 111,000 were issued and paid for. For their future requirements there remained to be issued 89,000 shares, representing £445,000, making up the balance of £1,000,000. There was no immediate probability of that part of the capital being increased. Comparatively recently the shareholders had also authorised the Directors to create preference shares of £5 each to the amount of £250,000, in order to get rid of the incubus of a debenture debt. Upon this issue £2 a share had been called up, leaving unexhausted £150,000 under this head available for the future requirements of the Company. They started the year 1889 having expended on capital account £373,703, and during the year they had spent the shareholders' money somewhat rapidly, the outlay having been £131,555. They had received on capital account £649,750, and the balance unexpended of that amount was £144,491. They, therefore, had this last-mentioned amount and the £150,000 unpaid on the preference shares assured to them in order to complete and develop their undertaking, in addition to which they had the reserve of ordinary capital which he had mentioned. They believed that the resources in hand were fully sufficient to carry out the undertaking as far as their existing powers were concerned. Passing to the reserve account, he observed that their enterprise could not be brought to perfection without their having to find out a great many things as they went along, and he was sensible that the accounts contained a great many items of expenditure which were very large in proportion to the result achieved. They had received on this account £27,638, and the balance of profit was only £1,249 ; but for the same expenditure they could, undoubtedly, have sold a great deal more current at 7¼d. per Board of Trade unit, a great deal more current under contracts, and have obtained a great deal more rental from meters, etc., than they had done in the past year. He hardly knew any enterprise upon which Parliament had a voice which had been so hampered and obstructed as the electric light. After referring in detail to some of the difficulties that had to be overcome even under existing legislation, he said that he felt convinced that next year they would show a better result on the revenue account than they did in the statement now submitted. Owing to the allocation to the Metropolitan Electric Supply Company of some of the districts hitherto supplied by the London Corporation, the customers and works of the latter in Marylebone and the Strand were being handed over to the Metropolitan Company. That company and themselves had what might be called the lion's share of London, and they were working on friendly terms with each other. As the result of the year's operations they were enabled to pay a dividend of 6 per cent. on the preference capital which had been received up to December 31, and to carry forward a balance of £920. Turning to the Directors' report, he alluded to the report of the engineer appended, and spoke of the wisdom of concentrating their works at Deptford. They had taken a lesson from the gas companies, whose experience, as Mr. Ferranti said in his report, "had shown them that the true way to secure both economy and efficiency was to generate gas on a large scale, on a commodious site by the water's edge and at some distance from the district to be supplied." As soon as they were in full working order at Deptford they would cease to generate the current at the Grosvenor Gallery, although that would still be a centre of supply. The applications for current were growing from day to day, and they could not meet the demands of the public upon them at present. They had adopted the high-tension system, which was different from that which other electric light companies had adopted. The experiment was now being tested by practice, and, like all experiments, it was not achieved in a single day, and a great many difficulties had to be overcome. Mr. Edison had visited the works, and had been astounded at what he had seen. Mr. Edison's lieutenant also subsequently visited the works, and had gone further than Mr. Edison in his comments, also stating they had done the right thing in concentrating their works at one place.

Lord Wantage seconded the motion.

A short discussion followed, in which Mr. Benjamin Kisch, Mr. Scott Russell, and the Lord Justice Clerk (Lord Kinsburgh) took part.

The **Chairman** having replied, the motion was unanimously adopted, and resolutions were afterwards passed declaring the dividend recommended, re-electing Earl Crawford, Sir Coutts Lindsay, and Lord Wantage to their seats at the board, and reappointing the auditors, Messrs. Kemp, Ford, and Co.

PROVISIONAL PATENTS, 1890.

MARCH 24.

4547. **Conducting telegraph, telephone, and other wires for electric lighting, &c., also pipes, tubes, &c., by means of oblong, square, or other suitably shaped blocks constructed in two halves, and having recesses, grooves, or perforations running longitudinally through them, into which the wires, tubes, &c., are to be laid. These blocks are adapted and constructed to take the place of the curb stones, and may be laid in crossings or other parts of roadways or other thoroughfares where they might be required.** Joseph Wilkinson, Richmond-terrace, Croft, *via* Darlington.

4557. **Improvements in field-magnets and supporting frames for dynamo-electric machines.** Frederik Vilhelm Andersen and John Owen Girdlestone, 14, Westdown-road, Catford, Kent. (Complete specification.)

MARCH 25.

4605. **Improvements in electric switches.** Alan Archibald Campbell Swinton, 66, Victoria-street, London.

4648. **Improvements in the construction of dynamo-electric machines.** Paul Frederik Degn, 41, Eastcheap, London.

4650. **Improvements in means or apparatus for producing periodical or intermittent motion by electricity.** Henry Boswell Palmer, 55, Chancery-lane, London.

4657. **Improvements relating to the soldering or uniting of metals by electricity and to apparatus therefor.** Henry Harris Lake, 45, Southampton-buildings, Middlesex. (Elihu Thomson, United States.) (Complete specification.)

4660. **Improvements in devices for heating and cooking by means of electricity, including electric flat irons and other articles.** Henry Rice Butterfield and Willis Mitchell, 45, Southampton-buildings, London. (Complete specification.)

4670. **Electrical heating devices for forging and analogous machines.** Oliver Imray, 28, Southampton-buildings, London. (John Ingersall Gilbert, United States.) (Complete specification.)

4700. **Improvements in or connected with arc lamps.** Adolf William Isenthal, Norfolk House, Norfolk-street, London.

MARCH 26.

4745. **Improvements in apparatus for applying or directing electric currents from dynamo machines or like generators of electricity.** Albert Essinger and Thomas Philip Christopher Crampton, 11, Hatton-garden, London.

4761. **Producing force or power by explosions of water or other liquid electrically.** Louis Carl Henry Mensing, 166, Fleet-street, London.

4767. **Improvements in electromotors and dynamos.** John Vaughan Sherrin, 77, Chancery-lane, London.

MARCH 27.

4788. **Electric advertising figures and models.** William Brown, Silcote, Claremont-road, Highgate.

4791. **An improved instrument for measuring electrical currents.** William Henry Douglas, 7, Cherry-street, Birmingham.

4821. **An improvement in insulated electric conductors.** Eugene Fred Aug. Obach, 28, Southampton-buildings, London.

4824. **Improvements in armatures for dynamo electric machines.** John Nebel, 28, Southampton-buildings, London.

MARCH 28.

4846. **Multiplying the illuminating powers of electric lights.** William Andrews, 116, Hunger Hill-road, Nottingham.

4858. **Improvements in multipolar dynamo-electric machines.** Gisbert Kapp, 70, Market-street, Manchester.

MARCH 29.

4921. **Improvements in galvanometers.** John Perry, Finsbury Technical College, Leonard-street.

4943. **Improvements in batteries for electrical purposes.** William Balch and Samuel Sidney Bromhead, 97, Newgate-street, London.

4949. **An improved electrolytic solution for galvanic batteries.** Louis Weigert, 191, Fleet-street, London. (Complete specification.)

4952. **Improvements in electric arc lamps.** Alexander Nicolas Contarini, 53, Chancery-lane, London.

MARCH 31.

4972. **Improvements in arc lamps.** Rankin Kennedy, 10, India-street, Kilmarnock.

4973. **Improvements in dynamo-electric machinery.** Ranken Kennedy, 10, India-street, Kilmarnock.

4974. **Improvements in electric meters.** Ranken Kennedy, 10, India-street, Kilmarnock.

4984. **Improvements in electric telegraph apparatus to transmit visible pointer indications corresponding to the movement of a transmitting handle.** Joseph Robinson, 1, Queen Victoria-street, London.

4991. **Improvements in electric arc lamps.** Albert Gay and Robert Hammond, 46, Lincoln's-inn-fields, London.

4992. **Improvements in electric recording apparatus.** Albert Gay and Robert Hammond, 46, Lincoln's-inn-fields, London.

4993. **Improvements in electric heating apparatus.** Albert Gay and Robert Hammond, 46, Lincoln's-inn-fields, London.

4994. **An improved arrangement of apparatus for obtaining currents of electricity.** William Sinnock, 2, Renfrew-terrace, Nunhead-lane, Peckham.

4998. **Improvements in the manufacture of illuminants for electric lamps.** Horace George Nichols, Bromsgrove, Brentwood, Essex.

5008. **Improvements in electro-telephonic apparatus.** Ernest Frank Furtado, 65, Chancery-lane, London.

5016. **Improvements in reversible machines suited for alternating electric currents.** Charles Paul Bary, 28, Southampton-buildings, London.

5023. **Improvements in electricity meters.** George Frederick Redfern, 4, South-street, Finsbury, Middlesex. (Antonio Fergés, Spain.)

SPECIFICATIONS PUBLISHED

1889.

5676. **Electric bells.** Reid and Kean. 8d.

5768. **Wooden casings for electrical conductors.** Garland. 6d.

7023. **Electric meters.** Snowdon. 1s. 1d.

7108. **Safety devices for high voltage circuits.** Drake and Gorham. 8d.

7275. **Arc lamps.** De Ferranti. 8d.

7428. **Electric accumulators.** Pollak. 8d.

8318. **Dynamo meters.** Ackermann. 8d.

9537. **Electric lamps.** Timmis. 6d.

16374. **Electric lamps.** Serraillier and Armstrong. 6d.

17088. **Operating mechanical devices electrically.** Irish. 1s. 1d.

20217. **Galvanic batteries.** Marx. 4d.

20400. **Recording indicators by electricity.** Murday. 8d.

1890.

1050. **Dynamo electric machines, &c.** Bollé (Gutmann). 8d.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The receipts for the past week amounted to £4,558.

Submarine Cables Trust.—This trust announce that the coupon, due in October last, will be paid in full, on and after April 15, by Messrs. Glyn, Mills, and Co., of Lombard-street.

Commercial Cable Company (Mackay-Bennett).—This Company notify that they will pay a quarterly dividend of 1½ per cent. upon the outstanding stock on the 10th inst. to all stockholders of record on April 1.

Western and Brazilian Telegraph Company, Limited.—The receipts for the week ended March 28, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,515.

Direct United States Cable Company, Limited.—The Directors of this Company have declared an interim dividend of 3s. 6d. per share, tax free, being at the rate of 3½ per cent. per annum for the quarter ending March 31, 1890, payable on April 24.

Telephone Company of Austria, Limited.—This Company intimates that the usual half-yearly dividend to the 31st inst. on the preference shares, at the rate of 6 per cent. per annum, payable, less income tax, early in April, has been declared by the Board.

Anglo-American Telegraph Company, Limited.—The Directors have declared an interim dividend for the quarter ending March 31 of 12s. 6d. per cent. on the ordinary and 25s. per cent. on the preferred stocks, less income tax, payable on May 1 to the stockholders registered on April 1.

Eastern Telegraph Company, Limited.—This Company announce the payment on the 15th April of interest of 3s. per share, less income tax, being at the rate of 6 per cent. per annum on the preference shares for the quarter ending the 31st March, and the usual interim dividend of 2s. 6d. per share on the ordinary shares, tax free, in respect of profits for the quarter ended the 31st December, 1889.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Anglo-American Brush	—	2½
— Pref.	—	1⅞
India Rubber, Gutta Percha & Telegraph Co.	10	18
House-to-House	4½	5
Metropolitan Electric Supply	—	5¾
London Electric Supply	5	3
Swan United	3½	5
Crompton & Co., Pref.	—	5½
National Telephone	5	5¼

NOTES.

Business.—Times are so busy that the electrical machinists of Pittsburg are working double time.

Electric Railway at Baden.—An electric railway is to be constructed between the towns of Baden and Vöslau, in Austria.

Paddington.—The Vestry of Paddington are still considering who they shall ask to carry out their electric lighting contract.

Edinburgh Electrical Exhibition.—Mr. A. R. Bennett has been elected a vice-chairman of the executive council of the exhibition.

Teneriffe.—An animated discussion is now going on in Santa Cruz, Teneriffe, as to whether the public lighting shall be electricity or gas.

Electric Welding.—Sir Frederick Bramwell will lecture on welding by electricity on Friday evening, April 18, before the Royal Institution.

Bernstein Lamps.—The manufacture of Bernstein low-tension lamps for use in series lighting is being introduced into France by M. Cadiot.

Torpedo.—The new type of torpedoes for the Austrian Government are understood to be driven electrically and protected by cellulose armour plates.

Brighton.—The time for sending in tenders for supply of plant for the electric lighting of Brighton has been extended to the 16th of April at 11 o'clock.

Paris-Brussels Telephone.—During the past fortnight Paris subscribers to the telephone have been placed in connection with Brussels up to midnight.

Auxiliary Dynamo.—M. A. Ledieu at the Academy of Sciences gave a description of the regulation of the movement of governors by means of an auxiliary dynamo.

Spain.—We are informed that the Municipality of Guadalajara have submitted to the Spanish Government the basis for a proposed tender for the lighting of the town by electricity.

Japan.—A national industrial exhibition will take place in Tokio, Japan, from April 1 to July 31, this year. It will show the progress in home products in art, science, and industries.

Halifax.—The Halifax Town Council have accepted the tender of the Halifax Mutual Electric Light and Power Company, Limited, for lighting certain portions of Belle Vue with electricity.

Registering Dynamometer.—At the Academy of Sciences, Paris, M. Mascart presented a note on a direct-reading transmission dynamometer with a photographic registering arrangement.

New Milan.—An installation of 10,000 lamps is about to be put down in a new quarter of Milan, at a cost of 500,000 lire. The works will be under the immediate superintendence of Signor Lieb.

Edison's Exhibit.—The entire exhibit of Edison's inventions as shown in the Paris Exhibition will be transferred to the Lenox Museum, New York, where a six weeks' electrical exhibition is to be held.

Paris Exposition Jury.—A fête will be organised to take place on the Eiffel Tower on May 3rd next, for the members of the various juries, to celebrate the anniversary of the opening of the great Paris Exhibition of last year.

Mackay Cables.—The Postal Telegraph and Cable Company has voted to increase the capital stock from £1,000,000 to £2,000,000, in order to pay Mr. J. W. Mackay for properties owned by him and worked by the company.

Ozone.—Considerable attention is being paid in various quarters to the electrical process of producing ozone, first invented and introduced by Mr. Ernst Fahrig, of Listria Park, London, who has for some time established works at Plaistow, Essex.

City Lighting.—A special meeting of the Commissioners of Sewers is called for Tuesday, April 29th, to consider the four applications now being made to the Board of Trade for provisional orders and to consent to one or more of such applications.

Trusts.—A piece of news published yesterday by Reuter's telegrams is interesting alike to electrical as other industrial concerns as regards American business. This is that the American Senate has passed the Anti-Trust Bill, only one member voting against it.

Siemens Works.—A visit was paid to the electrical works of Messrs. Siemens and Halske in Berlin last week by the foreign members of the Labour Protection Conference. The visit lasted over an hour and a half. The party was conducted by the chief engineer Frischen.

Society of Arts.—On Wednesday, May 7, before the Society of Arts, papers will be read on "The Aim and Scope of Higher Technical Teaching," by Dr. Percy F. Frankland; and on May 14 on "Prof. Elihu Thomson's Electromagnetic Induction Experiments," by Dr. J. A. Fleming.

Port of Barcelona.—The public authorities of the Port of Barcelona have decided to recommend that the electric light shall be permanently established in the modern parts of the port, reserving gas for the parts which will require modification or repair, presumably with the idea of introducing the electric light in these also later on.

South German Telephone System.—The Frankfort Chamber of Commerce has addressed a petition to the postal authorities in favour of erecting a telephone network to connect the leading business places of South Germany. The preliminaries are already settled, and the realisation of the project will probably be not long delayed.

Electric Welding.—The Electric Welding Syndicate, which is showing the Thomson process of electric welding in this country, is understood to be about to launch a large company, with a capital of £460,000, to work the system. The capital of the American Welding Company was, we believe, equal to £300,000.

Popp System.—A lecture was recently given by Prof. Reidler, of the Berlin Technical High School, at Offenbach, ardently advocating the Popp system of distribution by compressed air as used in Paris. A petition for leave to erect a compressed air installation at Offenbach has been addressed to the town authorities by the Berlin Popp Company.

Huesca.—The installation in the capital of Alto Aragon has been started. The dynamos are of 100 volts, but lamps of 50 to 55 volts are employed, mounted two in series. The tariff is fixed at 7 pesetas (about 6s.) per month per lamp of 16 c.p., burning from dusk until midnight, the subscriber paying the cost of interior wiring and fitting.

A Verb for Electric Traction.—The following are the various words which are suggested by correspondents in answer to Lord Bury's request in the *Times* for a single verb to express electrical propulsion: To motor, mote, electricize, electrize, electrate; to tric (and tricking); to run, speed, squirm; to spark, gleam, flash; to coulomb, volice or volize, and to amber.

Premiums.—The Société d'Encouragement of France announces various prizes for 1891, among which are the Melsens prize of 500 francs for an application of physics or chemistry to electricity or hygiene; a prize of 3,000 francs for the means of transmission of natural mechanical force to long distances; and a prize of 2,000 francs for an industrial preparation of ozone, and its applications.

Electric Welding in Birmingham.—A visit was recently paid by several members of the South Staffordshire Institute of Iron and Steel Works Managers to the Birmingham Compressed Air Company's works to witness experiments in electric welding. A representative of the Electric Welding Syndicate met them and conducted the experiments, which were very satisfactory.

Power Station.—A favourable offer is made elsewhere which may prove of interest to electrical engineers on the look out for further developments in lighting or power distribution. The premises to be acquired contain steam power already applied, six dynamos of a total capacity of 500 amperes, with space for extension, and are connected with a system of tramways which it is hinted might well be exploited by means of electricity from this station.

Working Men's Exhibition.—An exhibition was held on Saturday, at the Holborn Central Hall, by the Working Men's Club and Institute Union of work by men in all ranks of industry. In electrical work, W. S. Steljes, of the Enterprise Club, showed a Wheatstone bridge of his handiwork. The exhibition is the first of its kind yet held. It is under the presidency of Mr. Hodgson Pratt, and deserves encouragement and help from both artisans and employers.

Electric Tramways in Hanover.—One of the first towns in Germany to utilise in anything like a practical manner the traction by electricity will be Hanover, where several lines are to be constructed between the town and the various suburbs. Two lines will traverse Linden, where large numbers of factories are situated, one extending to Pattensen, the other passing along the Bad Limmer, ending at Benther Berg. The third line will run to the villages to the north-east of Hanover.

Telegraph Congress.—The International Telegraph Congress is to open in Paris on May 15. It will be held in the Prince Imperial's riding-hall at the Louvre. This hall has been used for some time as a general storeroom for articles for which no place could be found in the national museums, and for that reason there was at first some opposition to its selection. This, however, has been overcome, and the work of clearing out the hall and preparing it for the congress has been begun. The cost will be upwards of 10,000f.

Reading.—At the monthly meeting of the Reading Town Council last week, the Mayor moved a resolution to the effect that the Messrs. Laing, Wharton, and Down Syndicate be empowered to supply the electric light in the borough for public and private purposes. The Deputy Mayor moved an addition that the licence should be subject to the conditions imposed by the committee, and to an undertaking that the resolution shall not operate as a consent under the Acts. The addition was agreed to, and the resolution was passed.

Transfer of Orders at Beckenham.—The representatives of the Beckenham Local Board have had a conference with the Board of Trade and the promoters of the Crystal Palace District Electric Lighting Order, and a satisfactory arrangement was come to with the exception of one of the clauses which had reference to the transferring of the order. The Board of Trade absolutely prohibited the assignment of the order. Upon the question of purchasing powers it was finally agreed that a clause should be inserted by which the Beckenham Local Board will have the right of purchase after a period of seven years and within 15 years with the addition of 33 per cent. on the undertaking, the power of purchase being left entirely to the option of the Board.

No Commutators.—We have news of a new invention or improvement in dynamos which is being confidently looked forward to as an essential step in advance in the manufacture of dynamos. This is a direct-current dynamo without commutator. It is the invention of M. Berlin, of Paris, and is being tested practically by the Continental Edison Company, from whom, if the tests prove satisfactory, further details will doubtless be obtained. Considerable secrecy is being secured in the manufacture, as the patents are not yet completed, but the improvement would seem to be considerable from the point of view of simplicity of construction, while, if practical, the saving in wearing of commutator and sparking will naturally greatly commend it to electrical engineers.

Obscure Streets.—A fatal accident which occurred last week in Paris is an illustration of the value which the proposed lighting of some of the more obscure streets by electricity may be expected to be in human life. It seems that a workman dressed in a neat white blouse having the appearance of a stonemason fell in the Rue de Rambouillet, possibly with effects of drink or possibly in a fit. The exact circumstances are not known, for the street being at that point quite in darkness, the driver of a wine dray passed along, and not being able to see the unfortunate man the dray passed over his body, completely crushing his chest and head. The affair may probably cause another lamp to be erected at the spot, but there are many points where more light would obviate both accidents and crime.

Diminutive Electromagnets.—A correspondent of the *Scientific American* gives some hints to students upon the construction of small electromagnets at very little cost, which work well for home-made telegraph sounders, circuit breakers, etc. If they will file off the head and point of a $2\frac{1}{2}$in. wire brad, and hammer it into the shape of a horseshoe, they will have the core. This is then to be wound with two layers of No. 30 cotton-covered wire. The whole operation should not take more than five minutes, and the magnet, used with one Grenet cell, will sustain about an ounce. These magnets, moreover, cannot cost more than a fraction of a penny apiece, if made in any quantity, and might be sold for a few pence. Finally, considering their size (about that of a large thimble) they are extremely portable and astonishingly strong.

Dynamine.—A new mineral oil, having the consistency of butter, has recently been introduced to the manufacturing public by La Compagnie Française des Graisses Minerales Consistantes. The new substance is not acid, and is free from resinous matter and drying oils. It is very stable in character, and does not undergo any change when exposed to the air. Its buttery consistency does not appear to be due to the addition of paraffin, vaseline, or wax to a liquid oil, as it has a definite melting point at 84deg. C., and does not inflame at a temperature lower than 220deg. In colour it resembles butter, and it has no appreciable odour. These properties give it an especial value as a lubricator, and as it has no chemical action on metals dynamine is likely to be extensively used for this purpose.

Bolton.—Circulars were recently sent out by the Corporation authorities to the principal gas consumers in Bolton, setting forth the probable cost of introducing electricity, and asking whether they were or were not favourable to the new departure. Altogether about 1,700 of these circulars were sent out. Many responses were received accepting if the light were as cheap as gas, but out of this number only about 50 consumers have expressed themselves absolutely desirous of being supplied with the electric light at the suggested price, which was somewhere about double that of gas. No determination was arrived at, but it is understood that the ultimate decision of the committee will be to the effect that there is not sufficient public demand at present to warrant them entering into negotiations for the supply of the illuminant.

Dorchester.—At the April sitting of Dorchester Town Council, a letter was read from the Board of Trade in reference to the permission the Council had given Mr. H. S. Frost, of the King's Arms Hotel, for laying underground electric wires for the supply of electricity to his premises. The letter pointed out that it was undesirable that mains for the supply of electricity should be laid down in any public street unless parliamentary powers had been first obtained for so doing, and asked to be furnished at once with further information in regard to the matter. It was mentioned, in the course of a discussion which ensued on the point, that Mr. Frost could be compelled to discontinue his arrangements in the event of this being found necessary, and it was decided to write to the Board of Trade informing them that the arrangement which had been come to was only of a temporary character.

Marylebone.—The Metropolitan Electric Supply Company have given due notice to the Marylebone Vestry, in pursuance of their agreement with that local authority, of the intention of the company to lay cables under the footways (near the kerb) in Oxford-street, north side (Rathbone-place to Duke-street); Duke-street, west side; Manchester-square, west side; Manchester-street, west side (Manchester-square to South-street); South-street, both sides; Marylebone-lane, chiefly on the east side; Bulstrode-street, south side; Welbeck-street, west side (from Bulstrode-street to Wigmore-street); Wigmore-street, north side; Cavendish-square, north side; Cavendish-place, north side; and Regent-street, west side (from Cavendish-place to the Circus), thereby connecting Rathbone-place generating station with the Manchester-square station. It is understood that the Vestry will offer no opposition to the work being proceeded with at once, provided the company agree to remove their pipes at their own expense where any owner wishes to reconstruct his vaults.

Moet et Chandon.—The extensive premises of MM. Chandon and Cie. at Epernay, whence comes the celebrated Moët et Chandon champagne, have been fitted with a complete installation of electricity, both for lighting and for traction purposes, when dealing with the wines. Babcock and Wilcox boilers are employed, supplying steam for three Breguet engines, double cylindered, at 350 revs. per minute, each driving two dynamos. Three of these dynamos supply current for the light, 250 amperes each, 100 to 115 volts. These are Breguet machines, Pacinotti-Gramme type. Three other dynamos are of the Manchester type, two for transmission of power, 55 amperes, 250 volts, and one for arc lighting, 200 amperes, 70 volts. Roffard motors are used, made by Breguet. The pumps, hauling apparatus, rincers, etc., are all driven by electricity, while the whole of the premises, including cellars and dwelling-houses, are lighted up, making a most complete and successful installation. A large number of other champagne growers are following suit, and having their own electric installations.

Accident in Paris.—On March 29, at a quarter to seven in the evening, an accident occurred at a house in Paris, 26, Boulevard des Italiens. There is on the ground floor a newspaper and bookseller's shop, and both gas and electricity were laid on, with no great precautions apparently, for it is stated that the services were in contact in several places, meaning, doubtless, that the electric fittings were affixed to the gas brackets. Electricity was not being used, though the meter was on. At the hour indicated a blue flash was observed at the main gas tap and also at a group of gas lights some 25 yards further along and on the floor above. No great damage was done, as the fire was extinguished and the places repaired immediately; but the inferences suggested were that an escape of gas in the box of the gas main was ignited by another escape of electricity, and that the pipes further along were melted by the same cause. The accident, though fortunately not serious, is a sufficient warning of the necessity for thorough precautions against contact or proximity of the two services.

Chlorate of Potash.—A manufactory has been established under the name of the Société l'Electro-Chimie, at Villers-sur-Hormes (Oise), for the electrolytic production of chlorate of potash by the patented process of Gall and Montlaur. A second and more important works is to be established in Switzerland, at Vallorbe. The raw material is chloride of potassium in aqueous solution. The electrodes are surrounded by diaphragms, of which the composition is kept secret. The current should measure five volts at the terminals of the bath, and it produces a decomposition of the chloride of potassium according to the formula

$$KCl + 3H_2O = KClO_3 + 6H.$$

In practice several baths are mounted in series, and at the Villers-sur-Hormes works the current is 1,000 amperes at 25 volts. The output is at present 1 kilog. (2⅕lb.) of chloride of potassium per 20 h.p. hour. This would correspond with ½cwt. of coal. The process is extremely interesting, but it cannot be expected to be remunerative except under those conditions where natural forces could be utilised.

Electrical Club.—Facilities we have in the electrical profession for meeting professionally at the meetings and discussions of the Institution of Electrical Engineers, and the Electro-Harmonic serves an admirable purpose in allowing disjointed conversations and handshakings amid brilliant displays of instrumental ability, but neither of these provides for that desire for intimate social knowledge and contact which the electric clubs of the States provides for their members. The Dynamicables certainly used to allow its members to talk dynamics and to "dine amicably," but its functions are erratic, and we hear but little of that formidable society now. A feeling is manifest that something more is needed. The question has been actively taken up by some prominent electrical engineers, who have considered the question, and have now arrived at a distinct proposal. An electrical club is desired, select, central, and with all the internal conveniences of a good clubhouse. It was found that the idea of the formation of an entirely new club must be dismissed on account of the limitations of numbers, and we understand it has been finally decided to affiliate with an already formed club upon a favourable basis. The Whitehall Club has been selected as already a well-known representative club of the civil and mechanical engineering professions, and the committee have agreed to dispense with the formality of the entrance fee in the case of members of the proposed club joining in a body.

Electrolytic Bleaching.—A St. Petersburg electrical paper describes a new system of bleaching invented by M. Stepanoff, in opposition to that due to M. Hermite. Instead of employing chloride of magnesium, very rare in Russia, M. Stepanoff takes sea-salt, which is very common and cheap. An hydraulic pump pumps a solution of this salt into special receptacles where electrolytic action is produced by the current from a dynamo. The decomposition having taken place, the same pump pumps back the solution of chlorine into reservoirs where the bleaching is to be effected. The electrolytic apparatus forms a case divided into 10 compartments communicating together, and in these are placed electrodes in platinum and lead. The saline solution is poured into the 10 compartments at the same time. The model of M. Stepanoff requires a current of 40 amperes and 45 volts; its size has been calculated to furnish 300 litres of solution per hour, equal to 83lb. of chloride of calcium per 24 hours. The apparatus does not require any special care. A workman empties and fills it from time to time. Although the solution may contain as much as 1·6 per cent. of chlorine, for economical reasons the inventor prefers not to pass 0·7 per cent. In the Hermite process, it is stated, the solution is never obtained of a strength greater than 0·3 per cent. Another advantage is the use of lead instead of zinc, which is used up, or becomes covered with impurities, necessitating special cleansing. Besides this, the amount of platinum required is only one-third.

Electric Launches at Edinburgh.—The electric launches will doubtless prove one of the chief public attractions at the Edinburgh Exhibition. The following details will prove of interest to technical readers: The four launches will run in the canal which is included in the exhibition grounds. They are designed by Messrs. Morton and Williamson and built by T. B. Seath and Co., Glasgow. They are 40ft. long, 6ft. 6in. wide, and draw 2ft. 1in., and have a carrying capacity of 40 passengers. The electrical equipment has been supplied by Messrs. M. Immisch and Co., London, and is similar to that used on the Thames electric launches. The charging plant will consist of a 25 h.p. engine and an Immisch dynamo, with suitable switch arrangements for charging four launches at the same time. The motors are capable of an output of about 3½ brake h.p. at 800 revolutions per minute. The propellers are coupled direct to the motor shafts. A ball-bearing thrust bearing is attached to the motor bed, and is constructed in combination with the plain bearing of the motor. This arrangement is the invention of Messrs. M. Immisch and Co., and has been patented by them. By its use the friction is reduced to the minimum, and there is no noise or vibration. The high-speed propellers have been made after a careful course of experiments, and give the highest efficiency hitherto attained with such small blades. They are designed for going both ahead and astern. The steering, starting, and reversing gear is so arranged that one man has the launch entirely under control.

Bavarian Telegraphs.—The laying down of underground telegraph wires is at last to be begun in Bavaria. A Bill on the subject will be laid before the present Bavarian Diet. The main lines may be from Munich to Ingolstadt, Nuremberg to Bayreuth, or Munich to Landshut, and Regensburg and Bayreuth to the Saxon frontier near Hof, to be connected with the existing imperial line from Berlin to Dresden. To establish a direct underground connection between Munich, Hof, Dresden, and Berlin, representing a distance of 850 kilometres, the Imperial Post Office will also have to lay down a wire 216 kilometres in length between Hof and Dresden. The splendid results obtained by the substitution of underground for overhead wires are well known. When the frequent interruptions occurring in countries not possessing such an underground network are compared with the regularity in the German telegraph service—the great storms of last year never once cut off the communication between the large towns—we cannot but admire, says *Kuhlow's Gazette*, the far-sightedness of our telegraphic authorities, who in a short time have established and perfected a system of such great value. Since 1877, 5,669 kilometres of underground wires have been laid, with 38,000 kilometres of wires; all important commercial towns and seaports, and every fortress and naval port, are now connected with Berlin in this secure way. Bavaria alone has hitherto not been connected with this network, and it is a matter of satisfaction that the neglect is about to be repaired.

Electric Railways. — An exceedingly interesting paper by Mr. Joseph Wetzler appears in the new number of *Scribner's* upon the progress of electric railways. The paper is charmingly illustrated in the soft, graceful style of American wood engraving, and deals in some detail in both a literary and scientific spirit with the electric tramway and railway as known at the present in the States, and as they may be expected to become. Mr. Wetzler describes the various leading systems of electric tramcar propulsion, giving special attention to the manner of erecting and running the overhead conductors, with illustrations of these systems. Among other interesting points, he alludes to the success of the motor as a tractive power being due to small details of engineering, mentioning the spring carriage of the motor as preventing shocks and permitting easy starting of the cars; and also to the immense effect in efficiency which has been produced by the seemingly slight detail of the use of solid carbon brushes instead of the copper ones, now almost universal in American street railways. The heavy Daft electric engine is described and illustrated, and the prospect of our heavy trains being shortly run by electricity is discussed and approved. The article finally mentions the Weems quick-speed scheme, in which a cigar-shaped car is to be hurtled through space guided by a skeleton track at the speed of some 400 miles an hour, which the author himself has already seen tested, watch in hand, on an experimental track, at the rate of 120 miles an hour—two miles a minute.

Flexible Mouldings.—A new idea in mouldings for electric light wires is brought forward by Mr. John A. Seely, of New York. Its purpose is to obviate the disadvantage of joints in ordinary wood moulding, and to do this a flexible moulding is introduced of some elastic and waterproof compound upon a canvas backing, with the two wires entirely embedded at the correct distances apart. The conductors for a house can then be reeled off a drum as a cable. The flexible moulding is ornamented by beads or other configuration, and is made to represent wood, and in all colours to harmonise with the fittings of the buildings on which it is intended to be used. At the corners of a room angle pieces of porcelain are used, each with a strip of permanent conductor running round the angle and terminating with screw heads or soldering pieces. The wires from the moulding are run close up to these and fastened thereto. If necessary, the flexible moulding is made without wires, which can be threaded through holes, or, if desired, the moulding can be made in two as in ordinary casing. In the combined form first mentioned the amount of work to be done in wiring is considerably reduced, as wire and moulding are run at once. The wire being continuous, there would also be little waste, as both wire and casing can be cut off exactly to the desired length. It seems to us a question whether the advantages of wood casing, admitting of easy examination and proper radiation heat, would be sufficiently substituted to ensure its practical use. Still the system may be worth the attention of house installers and wire manufacturers.

Birmingham Victoria Courts.—At the meeting of the Birmingham City Council last week the Mayor (Councillor Clayton) moved that the General Purposes Committee be authorised to provide for the lighting of the assize courts, known as the Victoria Courts, by electricity by the Birmingham Electric Supply Company, at an estimated cost not exceeding £2,000. Having explained the circumstances which led the committee to substitute electric lighting for gas lighting at the courts, the Mayor said that they were now all satisfied that electric lighting had got beyond the experimental stage. He had travelled thousands of miles on board ship where the only lights used in the parts of the ship inhabited by passengers was the electric light. The committee felt, however, it would be such a dreadful thing to have a breakdown while the judges were sitting—it was too awful a thing to contemplate—that they had decided to make a small provision for gas lighting. The electric light had now got past the experimental stage; it was a good light and a healthy light, and, considering the relative cost of electricity and gas, they ought to be willing to encourage its use rather than have it thrown in their faces that, because they were the proprietors of a gas undertaking, they had neglected to observe the motto of the town. Several members who took part in the discussion thought the Gas Committee ought to be given the chance to see what they could do, and others protested against the extra expense, seeing the courts were only used occasionally. Sir Thomas Martineau, who seconded the motion, said that the matter of lighting was not a part of the contract. It was left open, and it had to be dealt with now in one form or another. The initial cost of lighting by electricity was lower by as much as £1,136 than that of lighting by gas, and, though the permanent cost would be higher, he believed the estimates of consumption contained in the report to be far in excess of what would be needed. Moreover, the greater cleanliness of electricity for lighting purposes would lessen the cost of cleaning and painting very materially. The Council would be false to its traditions if it proved unprepared to march with the times in this matter, and, though he earnestly hoped that the magnificent success of the Gas Committee might continue, he thought it would be a great mistake of the Council to set their faces against what had been aptly described as the light of the future. The resolution having then been carried with but two or three dissentients, the report was approved.

London County Council.—At the last meeting of the London County Council Mr. Westacott (chairman of the Highways Committee) reported that the committee submitted contracts with Mr. J. W. Benson, the Electric Construction Corporation, Messrs. Elliott Bros., and Messrs. L. Clark and Co., for the supply of apparatus, etc., for the electric testing-station, the acceptance of whose tenders was reported to the Council on February 11 last. They recommended that the seal of the Council be affixed. This was agreed to. The committee also recommended, and it was agreed, that the consent of the Council be given to so much of the works referred to in the notices dated March 4 and March 12, 1890, respectively, of the Westminster Electric Supply Corporation, as are proposed to be carried out in Millbank-street, Wood-street, Great Smith-street, Orchard-street, Victoria-street, Eccleston-street, Buckingham-palace-road, Wilton-road, and Vauxhall-bridge-road, on condition that the company do give three days' notice to the Council's engineer before commencing work in any street; that the mains shall be laid under the footways wherever it is found practicable to do so, and that the covers of the boxes to be used shall consist of iron frames filled in with materials to suit the paving. That the sanction of the Council be given to the House-to-House Electric Light Supply Company on the same conditions to lay mains in Fulham-road, Radcliffe-gardens, Tregunter-road, The Grove, Boltons, Gilston-road, Courtfield-gardens, Nevern-road, Warwick-gardens, Earl's Court-road, and Hogarth-road. That the condition attached to the notices of the Council's approval of the works, which included the laying of mains in the subways in Shaftesbury-avenue, Charing Cross-road, and Garrick-street, by the Metropolitan Electric Supply Company requiring the company to give an undertaking to pay rent for the use of the subways, be not insisted upon. That the Council do sanction the laying of the Metropolitan Electric Supply Company's mains in that part of Charing Cross-road between Cranbourne-street and the parish boundary of St. Martin-in-the-Fields, in accordance with the notice, dated March 20, 1890, upon condition that the mains be laid in the subway and enclosed in iron pipe. That the positions to be occupied by the mains in the subway be subject to the approval of the engineer of the Council, and that the work of placing them be carried out to his satisfaction. That the clerk be instructed to forward to the company a notice requiring it to lay the mains in Charing Cross-road, referred to in the notice dated March 20, 1890, in the subway of that thoroughfare. That the sanction of the Council be given to the Metropolitan Electric Supply Company to lay mains in Oxford-street, Regent-street, Cavendish-place, Wigmore-street, Marylebone-lane, Welbeck-street, Bulstrode-street, South-street, Manchester-street, Manchester-square, Duke-street, Southampton-buildings, and Bedford-row. This was agreed to.

A PLEA FOR THE ELECTRICAL ENGINEER.

BY SYDNEY F. WALKER.

The striking advance which has been made in electric lighting during the past 10 years, and the large figures that are in contemplation in connection with the distribution of electric currents for lighting purposes, have for the time obscured other branches of applied electricity.

It has even been suggested that because the able mechanical engineers who have taken up the subject of dynamo construction are mainly to be credited with the advances which have been made in electric lighting, therefore electrical engineering *per se* is to be a thing of the past. For the future, those who would be electrical engineers must first be mechanical engineers, and then somehow obtain a smattering of electrical knowledge, and all will be well with them.

With this view of things the writer proposes to join issue. In his opinion, to be a mechanical engineer, or to have a knowledge of mechanical engineering—two valuable adjuncts to the electrical engineer—are not the be all and end all of electrical engineering any more than to be a chemist or to have a knowledge of chemistry are. More than that, he maintains that a knowledge of mechanical engineering, however profound, plus a smattering of knowledge of electricity, are not sufficient equipment for an electrical engineer—not even for an electric light engineer. The electrical engineer of the future, in the writer's opinion, if he is to properly represent his chosen profession, will be required to know everything about electricity, and as much as he can about everything else.

As with other branches of engineering and of applied science, electrical engineering comes in contact with and requires help from many other branches. The electrical engineer cannot go far, for instance, without some knowledge of mathematics, of chemistry, as well as of mechanics. If he is to apply his apparatus in mines, some knowledge of a mine *should* be his. If he is to apply, say, an electrical governor to a steam-engine, a knowledge of the construction and working of the steam-engine are essential to his success. And more than this, the greater his knowledge, the more intimate his acquaintance with mathematics, chemistry, mechanics, and of the conditions under which his appliances are to be used, the greater *must* be his success. But this knowledge must not be acquired at the expense of purely electrical knowledge, nor should the man who excels in any one of these, but who has only a slight knowledge of electricity, be called an electrical engineer. As the writer of this article pointed out some years ago, in the columns of the *Electrician*, the union of a knowledge of mechanical engineering, or of chemistry, with that of electricity must be to the advantage of the latter, provided that it be thoroughly mastered as well.

The electrical engineer must study electricity whenever and wherever he finds it—not only in the dynamo and the electric lamp, but in the telephone, the telegraph, in the depositing-vat, in its effect upon the human body, in its passage through the clouds, and through the earth's crust, and in every possible phase that it may be discovered.

And the reason is, if one is wanted, that the behaviour of electric currents under one set of conditions often throw striking illumination upon what would otherwise be very puzzling phenomena under a totally different set of conditions. The phenomena observable, for instance, in many cases, on the passage of a spark between parts of an apparatus designed for use with electric light, throw a wonderfully striking light upon many of the hitherto puzzling vagaries attendant upon the discharge of thunder-clouds.

The troubles of electrical engineers who have had experience with telephone circuits and sensitive telegraph instruments enable them to understand and to predict the behaviour of earth circuits when used in connection with electric light installations, and they are not too ready to utter the magic shibboleth "earth connection" as a panacea for the possible danger to life arising from a leakage between the primary and secondary of a transformer. They know that the safe path to "earth" for any troublesome E.M.F. is by no means so easily obtained, notwithstanding that earth connections often present themselves when they are not wanted.

The experiences also of the telephone man, with the wilful behaviour of telephone currents, and their persistent appearance in wires where they are not wanted, to which their only path could be by way of the earth's crust, will lead him, if properly applied, to a better understanding in part, at least, of the behaviour of earth currents.

Take, for instance, a case such as the following: At a certain colliery a dynamo machine was fixed on the surface to supply electric lights both there and underground. The manager of the colliery, who had studied electricity, took advantage of the presence of the electric light mains underground to displace the batteries he had been using hitherto for his electric signals. Finding this fairly successful, he proceeded to fire his shots for bringing down his coal by the same means. He found, however, that it was only necessary to run one wire to the shot hole, turning the wire from the other side of the fuze into the coal. Apparently all went well, yet on at least two occasions the polarity of his dynamo was reversed.

Two pertinent questions may be asked here. First, is this colliery manager an electrical engineer, seeing that he is a mining engineer with a fair smattering of electrical engineering; and, secondly, how would the mechanical engineer, or the chemist, or the mathematician, with only a smattering of electrical knowledge proceed to explain the phenomena. Evidently the only man who could do it with any reasonable certainty would be the electrical engineer. Again, the study of the behaviour of electric currents in the galvanic cells and in the depositing-vat, added to his experience in the actual use of insulated wires, should enable the electrical engineer to predict and therefore to provide for the action of the leakage current, however small, upon the insulation of electric light cables, or of those used for transmission of power. He will know that wherever a current can pass, no matter how small, it will do work upon the substance it passes through, and if the substance be one whose chemical composition or physical condition are changed in the presence of electric currents, such changes will inevitably take place. He will have learnt, too, possibly under circumstances that have impressed the lesson on his mind, not to despise small currents, and to have a great respect for the time factor. Here, of course, the experience of the mechanical engineer would be similar; he, if he has learnt his work at all well, has imbibed a wholesome respect for the time factor; but he would hardly, unless possessed of woman's intuitive genius, expect the time factor to be silently and quite imperceptibly breaking down the insulation of his cable. When the total collapse occurred it would be simply one of those puzzling things that "no fellow can understand." Again, the action of the electric current upon the human body can surely be best studied by the electrical engineer, associated by his own or someone else's knowledge of physiology. To him alone is it not uncommon to have a bundle of conductors of varying resistance, all jumbled together in a confined space, and to be able to measure or calculate the current passing through each, when a given E.M.F. is applied. He alone will be able to trace the connections of various derived circuits connected to the mains; and it would hardly occur to anyone but an electrical engineer to trace a variation in a measured resistance, when taken with the alternating and direct currents, to the known difference in the inductive effect of the two currents. It may not need a high degree of electrical training to guard oneself from expecting that, because a magnet is able to rotate a beam of light through several degrees, therefore it should have the same effect on one's own head. Possibly men not electrical engineers may recognise the prosaic fact that they are not all beams of light.

It is doubtful also whether the training of any but the electrical engineer would lead him to grasp the features of that strikingly beautiful phenomena, electrical endosmose. And doubtless numbers of cases will occur to readers of this article, where only the electrical engineer, the man who studies electricity first, and other sciences and arts only so far as they help him with that, could work his way through the problems that are constantly coming up for solution. Striking instances of the truth of this fact occur in the electrical patent cases that come before the law courts. So far the judgments given are not the result of mere chance; the cases are won by the side who have the ablest *electrical* engineers as witnesses—the men whom lawyers cannot puzzle by all sorts of impossible hypotheses. It is not the mechanic or the civil engineer with a smattering of electrical knowledge who wins the case, however able he may be in his own profession; it is the master mind in electrical matters. Put the matter, too, in another form. At the present time electric lighting is going ahead. Ten years ago its sun was barely visible above the horizon. Then it was the telephone which offered the best prospect for young men with a taste for electricity. What would have been thought in those days of a recommendation to serve an apprenticeship in a fitting-shop? Wouldn't an apprenticeship on a roof have been more appropriate? In a few years the secondary battery may offer even a better field than dynamos for young men of energy. What is to be their training? Surely if in anything, other than electricity pure and simple, it should be in chemistry. Yet everyone knows that chemistry, however carefully studied, would take them only a very short way. The laws of mechanics come in here, just as the laws of electrolysis come in in the dynamo and arc lamp. Or carry the matter a little further. To-day, or rather yesterday, certain mechanical problems presented themselves for solution in the dynamo; to-day certain chemical problems present themselves in the accumulator. A few years hence the problem may be how to apply heat directly to a mass of iron, or of iron and copper, so that an electric current may be the direct result, a problem involving a very close and intimate acquaintance with the laws of heat, magnetism, and a knowledge of mechanics.

To-day the problem is to convey a current for electric lighting from Deptford to Belgravia without waste, and without danger to life and property. Some years hence the great problem may be how to convey a ship across the Atlantic by means of accumulators and electromotors.

To-day the great problem in telephony is to speak the longest distance through wires above and below ground. A few years hence the problem may be to speak from ship to ship across a certain breadth of water without wires at all. Now the work is in a factory, then in an iron works, now in a mine, then in a steamboat; now it is a large current and small E.M.F., then a small current and high E.M.F., and so on, *ad infinitum*, moreover, probably, *ad nauseam*.

If this is so, how is the man who wishes to keep pace with the advance of electrical science to steer? Is he to become a skilled mathematician, a chemist, a mechanical engineer, a mining engineer, a geologist, a surgeon, a millwright, an iron works manager, etc., etc., all before commencing to study electricity or to earn his living? What age will he be when he does settle down, and how about the advances in one branch that are taking place while he is studying the other? Surely his course will be the same as that of the dear old tortoise in the fable. He will keep pegging away on the main road, seeing all he can of the surroundings, but never tempted from it by the prospect of any temporary gain, however striking it may appear at the time.

And, after all, there are plenty of able mathematicians, chemists, mechanical and other engineers, possibly even surgeons, who are ready and willing to give us the benefit of their special experience, if we are not too proud to take it, just as we are always willing to give any one of them the benefit of our experience in our special line. But, just as we note, and often laugh at, the grotesque and expensive blunders men make who dabble in electrical work without a knowledge of it, their mistakes often causing them 10 or 20 times the amount they could have had experienced assistance for, so we, if we are wise, should accept the aid of those skilled in the sister branches of science and engineering, and be prepared to pay fairly for it rather than attempt the impossible task of acquiring sufficient knowledge of all of them to carry us through every difficulty. Our work *must* be better for adopting this course, as every man does best that which he knows best. Let us be electrical engineers first, and what you please after.

FIELD-MAGNET COILS FOR DYNAMOS.

BY GISBERT KAPP.

The determination of the winding of any field-magnet coil to produce a given exciting power with a given expenditure of energy is a very simple operation, requiring no other electrical knowledge but that of Ohm's law and the ability to use resistance tables. But even the most simple operation, if it has to be performed over and over again, becomes tedious, and as in the design of field-coils we must to a certain extent proceed on the trial and error method, any comprehensive formula by which we can shorten the calculations will, in the long run, effect a considerable saving of time and labour. Such formulæ can easily be established, and are simple enough for daily use, as the author can testify from his own experience. In considering the kind of formulæ wanted, we may start from two distinct points of view; we may either make the total expenditure of energy the determinant factor, disregarding entirely the temperature to which the coil will be raised, or we may make the temperature the determinant factor, and take no account of the energy. The former method will be used in all cases where the total efficiency of the machine is the most important consideration, and the latter method where low cost and ability to pass a temperature test are paramount.

In either case it is assumed that the exciting power, X, of the coil expressed in ampere-turns has been found, or is given; that the thickness and width, or the diameter of the magnet core is given, and that the length of the former, upon which the coil is to be wound, has been settled as part of the general design of the machine. What we require to know is the depth of winding and weight of wire in the coil. It is convenient to be able to determine these quantities without having previously to ascertain the size of wire and insulation, number of layers, turns per layer, and resistance. All these quantities must, of course, ultimately be determined, but for the preliminary calculation in connection with a design which may be considerably modified before its final adoption, it is not necessary to know them. All we care to know is what room is required for the coil, and what will be the weight of wire in it if the limiting conditions of heating or waste of energy are to be fulfilled.

Take first the case in which the heat limit applies. The energy wasted must in this case be proportional to the surface of the coil. If we allow a cooling surface of $2\frac{1}{2}$ square inches, reckoned on the outside of the coil only, for every watt transformed into heat, the rise of temperature in continuous running will be from 20 to 25 deg. C., and this may be taken as a perfectly safe and satisfactory limit. The following symbols will be used:

δ .... Diameter of wire in inches.
L .... Length of former in inches.
D .... Depth of winding in inches.
R .... Resistance of coil in ohms.
τ .... Number of turns of wire in coil.
π .... Perimeter of coil in inches.
W .... Energy lost in watts.
X .... Exciting power in ampere-turns.
c .... Current through wire in amperes.

Neglecting for the present all numerical coefficients, we can establish a series of equations between these various quantities. The number of turns in the coil must be proportional to its sectional area, and inversely proportional to the square of the diameter of the wire, or $\tau = \frac{LD}{\delta^2}$.
The resistance is proportional to the perimeter and number of turns, and inversely proportional to the square of the diameter of wire,

$$R = \frac{\pi \tau}{\delta^2}.$$

The energy lost is proportional to the cooling surface,

$$W = \pi L.$$

It is also proportional to the resistance an[illegible] of current,

$$W = Rc$$

The exciting power is obviously given by the expression,

$$X = \tau c.$$

By combining these equations, we find

$$\pi L = \frac{\pi \tau}{\delta^2} c^2$$

$$\pi L = \frac{\pi X^2}{L D}$$

$$X = K L \sqrt{D} \quad . \quad . \quad . \quad . \quad (1)$$

Where K is a coefficient depending partly on the size of the wire and partly on the general dimensions of the coil. That this coefficient cannot be a constant is evident from the fact that in the above equation we have taken no account of the ratio between the space wasted by insulation, both of the former and the wire itself, and the space occupied by copper. This ratio is obviously a variable one, the waste being the less, the larger is the whole coil and the stouter the wire. The size of wire has, however, more influence upon K than the general dimensions of the former, and since, in the usual run of designs, the larger coil is generally wound with larger wire, we may determine K merely with regard to the size of wire. In designing a machine we know beforehand, within 15 or 20 per cent., what will be the diameter of the wire to be used for the field, and can therefore hit upon the value of K at once, provided we have determined K for various sizes of wire. To use formula (1) we must therefore have a table giving this value, and it is best to prepare such a table by reference to machines actually built. The table here given has been calculated for a cooling surface of 2·5 square inches per watt:

Diam. of bare wire in mils.	K.
40	522
120	542
200	570

It will be noticed that the variation in the value of the coefficient is comparatively small, so that a large error in the first guess as to the diameter of the wire to be used only results in a very small error in the final result. Equation (1) gives the exciting power obtainable with a coil L inches long and D inches deep. It can, of course, be brought into another form, so as to give the depth or length of coil for any desired exciting power.

The weight of the coil can also be expressed by a general formula, at which we arrive in a way similar to that pursued in arriving at equation (1). It is not necessary to give the method in detail. The result is—

$$\text{Weight in lbs.} = K \frac{\pi}{L} \left(\frac{X}{1000} \right)^2 \quad . \quad . \quad . \quad (2)$$

In this equation K is another coefficient, which must be determined with reference to the gauge of wire used, and the cooling surface allowed per watt. Where this is 2·5 square inches, we find the following table:

Diam. of bare wire in mils.	K.
40	·495
120	·520
200	·615

It will be seen from equation (1) that an increase in the length of the coil is more effective in augmenting the exciting power than an increase in its thickness, whilst equation (2) shows that the weight is diminished as we increase the length of the coil. It will be understood that the coefficient in (1) is only correct for the ratio of 2·5 square inches of cooling surface per watt. If a different ratio is adopted, the coefficients must be altered. Let q be the new ratio, then K for this ratio is found by multiplying the value of K given in the table by $\sqrt{\frac{2 \cdot 5}{q}}$. Thus, if the ratio adopted is 5 square inches per watt, then K for 120 mils. will be $\sqrt{\frac{2 \cdot 5}{5}}\, 542 = \frac{542}{1 \cdot 41} = 384$.

Taking, now, the more general case, in which we settle beforehand what amount of energy we can afford to waste in excitation, we use the above formulæ with exception of $W = \pi L$. We thus find, neglecting again all numerical coefficients—

$$W = \frac{\pi \tau}{\delta^2} c^2$$

$$= \frac{\pi \tau^2 c^2}{L D}$$

$$= \frac{\pi X^2}{L D}$$

Introducing, now, a coefficient, K, we have

$$X = K \sqrt{\frac{W L D}{\pi}} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

In this case, when the loss of energy is fixed beforehand, the exciting power is proportional to the square root of the depth of the coil, as in the other case; but it is also proportional to the square root of the length, and not to the length directly, as in the other case. An increase of length or an increase of depth will therefore be equally efficient. To get a compact design of machine short coils are desirable, and where economy of exciting energy is of first importance such coils can be conveniently used. Where, however, the temperature limit is of first importance, long coils are cheaper than short ones, and then the design of the machine will be less compact, and the iron part of the field will be heavier.

As regards the numerical value of the coefficient K in equation (3), this, of course, also varies with the gauge of wire. The following table gives it between the limits already mentioned:

Diam. of bare wire in mils.	K.
40	820
120	850
200	900

The weight of the coil is proportional to $\pi L D$. From (3) we find $X^2 \pi = W L D$, and multiplying both sides by π we have $X^2 \pi^2 = W \times \text{weight}$.

Introducing now a coefficient, K, and writing $\frac{X}{1000}$, instead of X, for convenience, we obtain—

$$\text{Weight in pounds} = K \frac{\pi^2}{W} \left(\frac{X}{1000} \right)^2 \quad . \quad . \quad . \quad . \quad . \quad (4)$$

For a constant expenditure of energy the weight increases as the square of the perimeter and as the square of the exciting power. If both perimeter and exciting power remain the same, the weight is inversely as the energy. The coefficient in (4) is as given in the following table:

Diam. of bare wire in mils.	K.
40	·195
120	·205
200	·246

Having by means of these equations found the dimensions and weight of the coil, it is an easy matter to find in the usual way the exact size of wire, turns per layer, number of layers, and resistance, according to the E.M.F. or current available, as the case may be.—*The Engineer.*

A POCKET DETECTOR.

The pocket electrometer recently introduced by Mr. Walker Moseley is intended to be a handy practical instrument.

The inventor states that he has long felt the necessity of such an instrument as the ordinary compass would constitute if put into special harness.

He was, he informs us, frequently propounding to himself the following problem: If a given radial line on a compass card can be extended hundreds of miles with successful accuracy, as is done by every steamer that crosses the Atlantic when it is kept on a straight course, why should not a smaller compass needle serve as a reliable and delicate balance for detecting and measuring all ordinary electric currents. He tells us that he first thought that as the compass needle was required only to point constantly north and south, the earth magnetism might vary without interfering with the compass, and hence no safe guide as a standard force, but remembering that for many years iron steamships had to be navigated by the compass, whilst its directive power was impeded by four or five large magnets placed round the compass to adjust it against local magnetism, there must have been overwhelming proof that earth magnetism is a constant quantity, and eminently serviceable as a standard force.

He also claims that once fixing a point on the dial to which the needle is deflected by a current of one ampere, there is no longer any necessity for a standard cell. For example, he has marked off on one side of the north and south line tenths, and 1, 2, 3, 4, and 5 amperes for testing batteries primary and secondary, as well as branch wires served with current from dynamos. On the opposite quarter of the circle he has marked off 1, 2, 3, 4, and 5 ohms for measuring resistances. Zero point for resistance being exactly opposite one ampere, hence, if any ordinary primary battery cell is short-circuited through a wire placed north and south to which the electrometer is hung, the needle will at first, when it ceases to oscillate, rest somewhere between one and two amperes, but in a very few minutes the current will fall till the needle points exactly to one ampere if the circuit which requires testing is then introduced; the opposite end of the needle will show instantly how many ohms, or part of an ohm, the resistance amounts to. In a similar way other kinds of measurement are performed, and the inventor is preparing other dials variously graded which are to be placed over the No. 1 dial, and for powerful currents, 20 to 1,000 amperes, the instrument has to be suspended by silk cords, one, two, three or four feet below the wire.

Moseley's Patent Pocket Electrometer.

As a wireman's detector it seems likely to displace for ordinary work the larger and more expensive instruments. As a pole detector it is, of course, all that could be wished, and as an educational instrument for students it will be useful.

The aim of the inventor is, no doubt, chiefly to provide an inexpensive waistcoat-pocket instrument for constant use where rule of thumb has hitherto prevailed. We notice that in his explanatory circular he says, "In common practice, if you look after the amperes, the volts will take care of themselves." This may mean, and it may be true, that voltmeters are often used when ammeters would be more serviceable. We leave that for those most interested in its solution to discuss.

CORRESPONDENCE.

MORE LIGHT ON ELECTRICITY.

To the Editor of the Electrical Engineer.

Sir,—I have just completed experiments which prove that a surcharge of electricity in passing through the glass of a Leyden jar by conduction alters the attraction of cohesion of the glass, so that when the jar is fully surcharged the attraction of cohesion of the glass is then 550 times greater than it was before the surcharging commenced.

I also find that the specific increase of the attraction of cohesion caused by a surcharge of electricity varies according to the nature of the substance operated on, and hence there is now a door opened for our understanding the Peltier effect and other electrical phenomena which have hitherto been inexplicable.—Yours, etc.,

James Johnstone.

8, Merchiston-park, Edinburgh, April 2, 1890.

PHYSIOLOGICAL EFFECTS OF CONTINUOUS AND ALTERNATING CURRENTS.

To the Editor of the Electrical Engineer.

Sir,—Please allow me, for my colleague, Dr. Harries, and myself, to reply to the letter of Prof. Forbes which you published last week.

That there is truth in the statement that the alternating currents from a dynamo differ from those produced by an induction coil it would be folly to deny, but the extent of that difference and its *effect upon the human body* is another matter.

Unfortunately for his case, Prof. Forbes proves too much. He writes: "The instrument employed measures the *effective* current." . . . "The discomfort measures the *maximum* value of the current"; and, further, 'Thus the current which caused discomfort was probably *20 to 25 times* the current measured."

If these statements be true, taking his lowest estimate of maximum current, and therefore, according to him, of *discomfort*, the alternating current which in our experiments produced discomfort was $1{\cdot}7 \times 20 = 34$ *m a.* On the other hand, Prof. Forbes appears to accept our discomfort figure for continuous current—viz., 10 *m a*; but the professor himself stated at the meeting that he *knew* he could not bear nearly as much alternating as continuous current, and several other speakers confirmed this.

As shown above, his letter proves that it takes *more than three times as much alternating current as continuous to cause discomfort.* In the days of Euclid this would have been called a *reductio ad absurdum*, but in the present day we need only adopt Prof. Forbes's own phraseology, and term *his* error a "fallacy."

In considering the effect upon the body of possible difference between maximum and effective alternating currents, we have to take into account potential counteracting effects of increased rates of alternation. Our experience, so far, is that the slower the rate of alternation, the greater the discomfort for the same current strength. Our paper dealt with a higher rate of alternation than that commonly in use in light circuits. It is, therefore, highly probable that the increased discomfort which would be produced by the slower alternations of a dynamo circuit would more than counterbalance the possible difference between effective and maximum current due to the use of an induction coil of much more rapid alternation.

Electricians generally show too marked a tendency to look upon the human body as an inanimate conductor and to apply to it the same laws.

I need hardly reiterate what Dr. Harries insisted upon in his reply at the meeting, that the physiological conditions controlling the resistance of the skin make all the difference in the results of contact.

Our paper deals exclusively (as we mentioned therein) with phenomena after contact, and deliberately excludes from consideration factors involved in bringing about that contact.

We desire to emphasise the difference between resistance and sensation, and trust that in future this important point will not be lost sight of.

As indicated at the meeting, we have further investigations in progress, and therefore forbear entering now more fully into the points raised.—Yours, etc.,

H. Newman Lawrence.

Institute of Medical Electricity,
24a, Regent-street, W.

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WANTED, A WORD.

Lord Bury, chairman of the Electric Traction Company, writes to the *Times* to say that a word, a verb to express progression by electrical means, is urgently required for immediate use. The Americans have already coined such a word, though the expression there used may appear somewhat flippant to English ears, but then the Americans are not given to weighing pros and cons. for six months before adopting something. According to our cousins across the Atlantic a steamer "steams," and, analogically, a motor "motes." How will this word suit Lord Bury? His launches will take half an hour to "mote" from Mortlake to Putney, or, again, 60 miles a day would be a fair day's "moting" for a small electric launch. We were old-fashioned enough to suggest "moteth," but the more modern disciple of Lindley Murray says old English is out of date, and that grammarians and word framers progress with the age, so "mote" let it be.

We are altogether averse to the adoption of a word coined from "ohm" or "volt," as suggested by Lord Bury, whose paragraph on this point we here reproduce. He says:

"When names were wanted for electrical standards of measurement, the patronymics of great electricians were called into requisition. They served the purpose well, and everyone now knows what an 'ampere,' a 'volt,' or an 'ohm' means. How would it do still further to extend that principle and use 'to ohm' or 'to volt' as an equivalent for 'to move by electricity'? For instance: 'An electric launch takes about half an hour "to volt" from Mortlake to Putney,' or, again, '60 miles a day would be a fair day's "ohming" for a small electric launch.'"

Perhaps the objection to "motes" or "mote" will be that the word exists as a substantive, meaning a small particle of matter. Similar objections may be taken to "elects" or to "circuits," though we might find many people favourable to the latter, for it savours of electricity and it already is in use as a verb, meaning travelling around.

The attempt to coin a word such as Lord Bury wants, indicates once more the idiosyncrasy of Englishmen to go straight at an object without circumlocution. We clip off the ends of words because it is too much trouble to say them, and, similarly, we want one word to express what has hitherto been expressed only in a round-about way by using half-a-dozen words. The philologists may have a fine time of it, and ransack Anglo-Saxon as well as classic literature to find a suitable word, which, after all, may not commend itself to "'Arry" and "Jack," the driver and conductor of the tramcar or "boat." The probability is that "motes" introduced by a joke, and by men who knew as much about philology as Johnson did about electricity, will survive, will gradually find its way into literature, and into the new dictionary.

Passing from the word, we may suggest to the "electrical engineer" another want, this time a "definition." In another part of this issue Mr. Walker discourses upon the "electrical engineer" and animadverts courageously against the idea so largely existing, that the better the mechanical engineer the better the electrical engineer. It is difficult to combat such an argument till we are able to get an exact definition both of a "mechanical engineer" and of an "electrical engineer." No doubt the man who knows everything about electricity, and something, be it little or much, about everything else, will be a giant amongst minnows—he will be the beau ideal of Brougham's learned man who should know "everything of something, and something of everything." What is the difference between an "electrician" and an "electrical engineer"? It seems to us that Mr. Walker combines the two into one. As we have had recently to remark elsewhere, a watchmaker may claim to be an engineer, but he is not ordinarily recognised as such, so an electrician may claim to be an "electrical engineer," but he is not ordinarily recognised as such. Few will be found ready to grant that "telephonists" of any shape or kind come into the class engineers. The term engineer, if it implies anything to the ordinary mind, implies someone who has to handle comparatively big masses of material, whether that material be iron or whether it be dirt. There is no objection to admit that an electric light engineer may have his eyes somewhat opened in regard to earth connection by a study of telegraphy or telephony, but he will certainly have them opened much wider by a study of "earths" in connection with dynamos. The men in Sheffield, Birmingham, Swansea, etc., who are daily engaged in electro-deposition may be electro-chemists, they are hardly electrical engineers. We think the latter title should be restricted to those engaged in manipulating and designing the heavy materials and large masses used in constructing and applying electrical apparatus. "Electrician" has perhaps a wider significance than "electrical engineer," and may include the latter. We hold strongly to the view that no electrical engineer is worth his salt unless he is a good mechanical engineer. Whether this view is correct or not, it is unmistakeable that the wonderful progress made during the past ten or fifteen years is almost entirely due to the mechanical engineer. He initiated almost every advance, and then the electrician stepped in and told him why he was right, patted him on the back, and said "It is good." Let Mr. Walker look round, let others look round, and note where the improvements come from. We quite agree that the electrical engineer cannot know too much, but if he waits to get information instead of working to make a thing go, he will not get far forward. When Hughes started on his printing instrument, he brought his mechanical skill to solve the problem. When Gramme took up the dynamo it was as a mechanical engineer, not as an electrician. Bell, after Reiss, certainly gave us the receiver of the telephone, though it was Hughes that made telephony commercially practical, though we hardly think either Bell or Hughes would look upon this as an engineering problem. The hydraulic engineer who knows all about the theory of fluids, and knows little about, say, cements, will not stand in the advanced ranks of the profession. Just so the electrical engineer must be an engineer first, and an electrician after. We leave these two questions almost as we found them, and say we want both a "word" to satisfy Lord Bury, and a definition to satisfy critics.

THE NEW WESTINGHOUSE ARC SYSTEM.[*]

It has been known for a considerable time that the Westinghouse Company has been elaborating a new system of low-tension arc lighting, and quite recently it has been advertised extensively, and put into practical use on something rather more than an experimental scale.

We are enabled this week to give our readers some important details concerning the operation of this very interesting system, together with cuts of the apparatus used.

The principle used is rather a departure in the way of arc lighting. A series of transformers is distributed along the line of the primary circuit, and the arc lamps are operated from the secondary coils of these transformers. The series transformer is especially adapted to working an arc system in very much the same way that transformers in parallel are so admirably suited to the needs of incandescent lighting. The conditions of series transformers are very favourable to steadiness of light from the fact that a large change in the resistance of the secondary circuit produces relatively but a small change in the current and E.M.F. of the secondary, consequently small variations in the resistance of the arc, and small irregularities of feed, will produce a comparatively slight effect upon the energy supplied to the lamp. This greatly tends to steadiness and regularity of the light. Even if the secondary were short-circuited, no serious results would be likely to follow by reason of the properties of the series transformer just referred to. With a dynamo properly self-regulating, and this arrangement of series transformers, the light obtained should be, as it is, steady and efficient. Inasmuch as each arc lamp is operated from the secondary coil of a transformer, the dangerous feature of the arc circuit is in a great measure removed, since unless the primary current should break through into the secondary, an accident which experience has shown is very unlikely to happen, no more than 50 volts E.M.F. is at any time in the lamp circuit, consequently an arc lamp operated on this system can (except for the danger of burning one's fingers be handled as safely as an ordinary incandescent lamp, and as the transformers can be, and are, placed outside the buildings they supply, there is no necessity for a high-tension current ever entering the walls of the building.

It should further be noted that not only does the alternating arc system possess these advantages, but it should be a very efficient method of distribution, for, as is well known, the modern transformer is exceedingly efficient when operated at its full load, and inasmuch as these series transformers are so operated, being from the nature of things free from the variations in load which can and do injure the efficiency of transformers in a parallel system of distribution, the loss in the transformation should be very small. In fact, it ought not to exceed 5 or 6 per cent., although no authoritative figures concerning these arc transformers have as yet been made public.

---

[*] Abstracted from the *Electrical World*,

The dynamo used in this new system of lighting resembles in appearance the ordinary well-known Westinghouse incandescent machine, its mechanical features being quite the same. The machine is reported as being extraordinarily well regulated, giving a current very nearly constant through an enormous range of E.M.F.

One machine is at present running in New York supplying 125 arc lamps scattered along the Bowery. Two other circuits of the same size are soon to be added, as even in this semi-experimental stage the lamp seems to be securing a considerable popularity.

The lamps are 2,000 c.p., using a current of 10 amperes, and having between their terminals a potential difference of about 50 volts. The primary current on the line is a little over 30 amperes, so that the transformer resembles an ordinary induction coil, in that it increases the tension and diminishes the current. As will be seen from these figures, the fall of potential on the primary circuit in each transformer is between 16 and 17 volts, consequently the dynamo operates at about 2,000 volts when supplying the full load. It is obvious that this arrangement makes it possible to supply far more lamps on a single circuit than has been found to be good practice with the ordinary arc system.

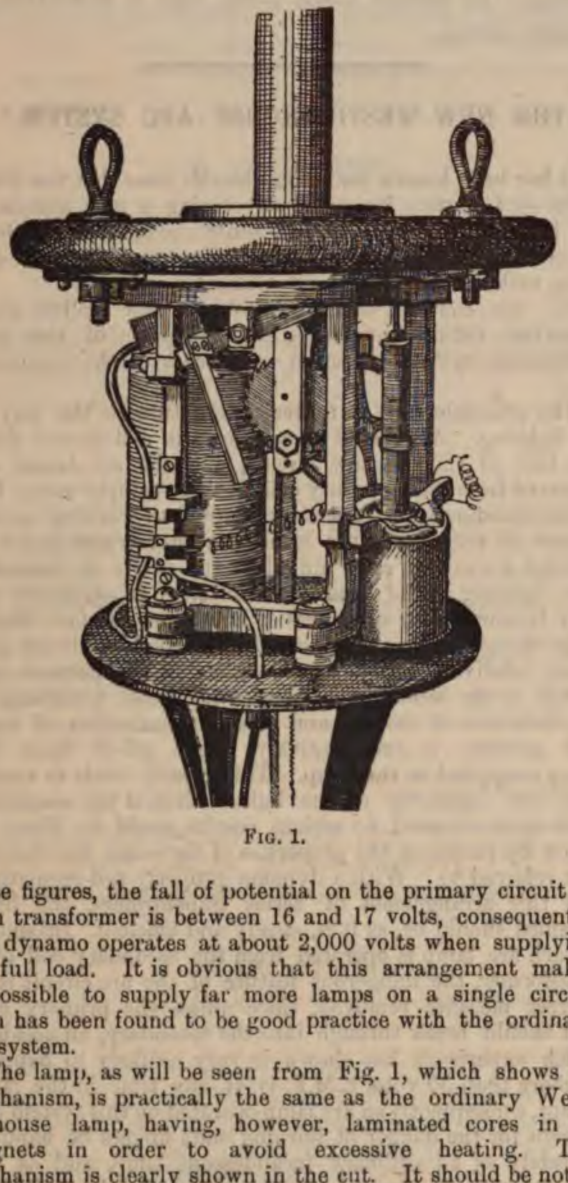


FIG. 1.

The lamp, as will be seen from Fig. 1, which shows its mechanism, is practically the same as the ordinary Westinghouse lamp, having, however, laminated cores in its magnets in order to avoid excessive heating. The mechanism is clearly shown in the cut. It should be noted that almost any arc lamp can be used on this circuit, but a special winding is necessary to secure regular feed.

It has been found best to employ on this circuit a rate of alternation decidedly less than that used for the incandescent system, the actual rate being very nearly one-half that of the incandescent machine. This renders the problem of arranging the feeding mechanism of the lamps much simpler, and reduces the heating to within very reasonable limits.

Both flat and round carbons have been used in these new lamps, the flat carbon being employed to give a long period of burning. They are 2¼in. wide, usually ⅜in. thick, and a little over 8in. in length, two of these carbons being placed in each lamp, instead of one long and one short carbon, as in the ordinary systems. These carbons are reported as giving 44 hours' continuous burning.

Besides the flat carbons, many ordinary round carbons ½in. in diameter and 8in. or 9in. long are used. These are reported as giving a light of about 13 hours, a period long enough to render double-carbon lamps quite unnecessary for all-night lighting.

The indoor lamp is ordinarily completely encased in a spherical globe of opal glass, and is principally remarkable for its compactness, it being but a little over 2½ft. in length. In the cut the globe is shown broken away so as to display the carbon holders and carbons within. The particular lamp sketched was, as will be seen, trimmed with flat carbons. It should be noted that when trimmed with round carbons these alternating-current lamps give a distribution of light quite different from that obtained with continuous-current lamps, for the reason that the alternating currents prevent the formation of the crater, which in many cases interferes with the free distribution of light.

In actual practice the lamps seem to give a clear, brilliant light, quite indistinguishable from that of any other good 2,000-c.p. arc light.

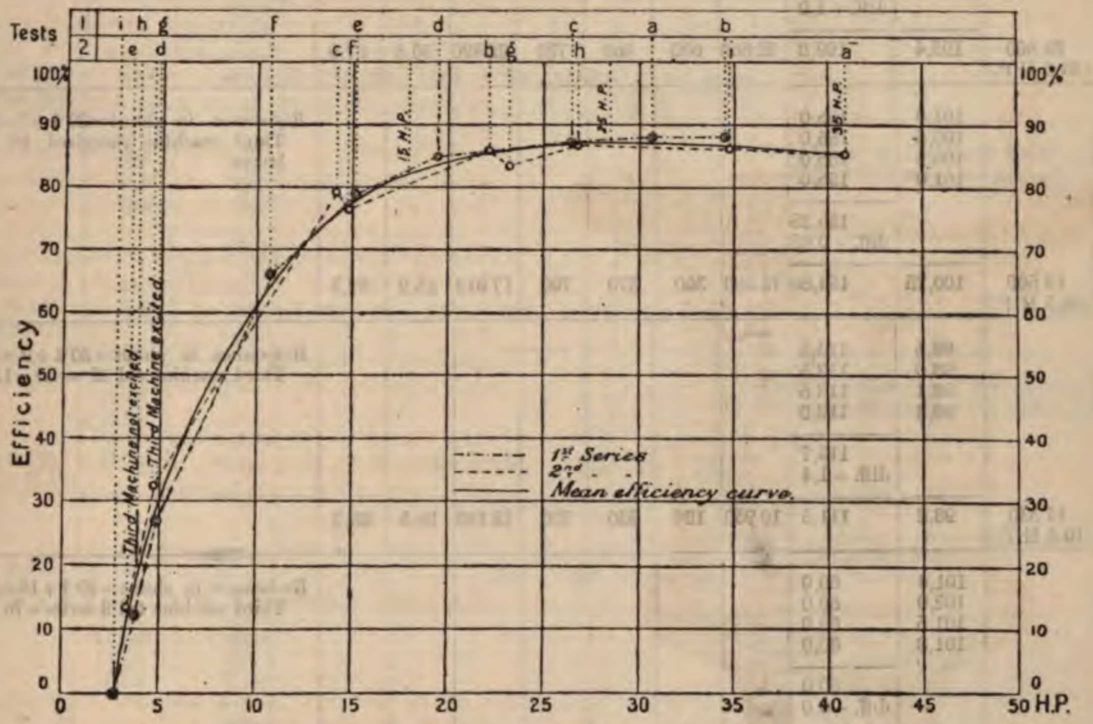
As will be seen above, the consumption of carbons is reported as being much less than with the continuous-current lamps. The fact seems to be well attested. The reason for it will be an interesting subject for investigation.

The transformer used in this system has nothing remarkable about its appearance, and its construction differs from that of the ordinary Westinghouse transformer principally in being arranged to increase the voltage and diminish the current, instead of the reverse. Special pains have been taken, however, in the insulation of the converters. A series of tests made for the United States Illuminating Company showed that the insulation from primary coil to box of the converter averaged between 30,000 and 40,000 megohms, and the insulation from secondary to box was nearly as great. These tests were made to ensure compliance with the underwriters' rules for insulation, and consequently the insulation from primary to secondary was not given, but the result reported was sufficient to indicate that it should be extremely good.

ELECTRIC LIGHTING PROJECTS IN FRANKFORT-ON-THE-MAIN.

Some time last year a technical commission, consisting of Prof. Galileo Ferraris, of Turin; Mr. W. H. Lindley, municipal architect of Frankfort; Dr. Kittler, professor of the Darmstadt High School; Mr. F. Uppenborn, director of the Experimental Electrotechnical Station at Munich; and Dr. H. F. Weber, professor at the Zurich Polytechnic School, was appointed by the Municipality of Frankfort to draw up a report regarding the introduction of the electric light into that town. The commissioners were to consider the possible dangers, the value of the competing systems, and to examine the plant proposed to be used by the competing firms. The companies concerned in the various projects were—Ganz and Co., of Buda-Pesth; the Helios Company, of Ehrenfeld, Cologne; Müller and Einbeck, of Hagen, Westphalia; Schuckert and Co., of Nurnberg; and Siemens and Halske, of Berlin. Several series of trials were made with the machinery submitted by these firms, and the results of which we shall shortly reproduce.

In the preliminary report of the commissioners answers were given to 12 questions which had been placed before them by the Electric Lighting Committee of the Town Council. The first question related to the comparative dangers of alternating and continuous currents. It was decided that with proper construction and management of the machines and apparatus all dangers to workmen would be avoided in both systems, and that in case of improper treatment of the machines and mains the effect of 2,000 volts pressure might prove fatal either with the alternating or the continuous current. With direct-current transformers the passage of the high-tension current into the secondary coil of the transformer would be impossible, owing to the separation of the secondary from the primary coil. If alternating-current transformers were used, the dangers for consumers would be so small that they need not be practically considered, provided that proper insulation and a sufficient distance between the secondary coils and the other parts of the transformer were maintained. The five-lead system of from 440 to 500 volts proposed by Siemens and Halske would not be more dangerous than other systems if carried out in an efficient manner. In dealing with the second question regarding alternating-current motors, the commissioners concluded that the efficiency of these was only slightly less than that of constant-current motors; that they do not start automatically, but require a second manipulation, although this is not considered a disadvantage; that there is produced on starting a lot of sparking at the brushes and commutator until the speed becomes normal; that the alternating-current motor is more noisy in working and would, therefore, in the case of large motors, be unsuitable for use in inhabited houses; that it is synchronous with the primary machine; that the alternating motor on being gradually overloaded would reach an effective duty of 60 per cent. above the normal load, when it would cease its synchronous movement and come to a stand; that the sudden unloading of the motor from its maximum to nothing effects no change in its course; that it can be used for working tramcars by the addition of intermediate mechanical appliances.



25 h.p. Alternate Current Motor, by Ganz and Co.—Graphical representation of Efficiency.

Concerning the third question of alternating-current transformers, it was found that the efficiency of Ganz's transformers was, when fully loaded, from 95 to 96 per cent.; when half loaded, from 93 to 94 per cent.; quarter load, 90; one-eighth load, 80 to 82 per cent.; and below this the efficiency decreased as the load diminished. These transformers should be worked to their best efficiency, and in order to do this when the consumption of current is least there should be provided an automatic arrangement for inserting and withdrawing each transformer from the circuit. The transformers would therefore be arranged in groups in such a manner that each converter would always work at full load, and the commissioners conclude that the automatic apparatus provided for this purpose by Messrs. Ganz was very suitable. Arc lamps were treated of in the fourth question. It was found that the average special illumination of the alternating-current arc lamp was, in closed rooms, to that of the continuous-current lamp as 1 : 1·23, or as 4 : 5; and that in the open air for an equal expenditure of energy the brilliancy of the two lights is as 3 : 4. It was therefore concluded that for an equal consumption of energy, the efficiency of the alternating-current arc lamp is 20 per cent. less indoors, and 25 per cent. less in the open; whilst the cost of the light is 2 per cent. more than that of the continuous-current arc lamp, owing to the greater consumption of carbons. With regard to the fifth question, dealing with meters for both alternating and continuous currents, it was decided that the former kind were not inferior to those of the latter type.

In reply to the next question, relating to continuous-current transformers, the commissioners deprecated the use of these where the primary and secondary coils were arranged on the same armature, but they did not see any reason for assuming that a continuous-current converter in which the coils were arranged on separate rings would not be safe and trustworthy. As, however, no such apparatus had been advanced, details of the cost could not be given. It was, however, considered that it would be of a more complicated character than an alternating-current transformer. The continuous-current converter shown by Schuckert was 12 per cent. less efficient than those of the opposite type. The seventh question concerning accumulators elicited a variety of opinions, two of the commissioners pronouncing for their use, two against, and one neutral.

The next question referred to the five-lead system of Siemens and Halske, which was considered as complicated, and the multiplication of cables and junctions would increase the possibility of dangers and accidents. In response to the ninth question as to the supply of current for electro-chemical purposes, it was decided that the consumption in Frankfort would be very small, and that it would be better to generate the current in the works than obtain it from a central station. The tenth point was as to what further remarks the various documents and projects and observations made during the experiments gave rise. The principal consideration was the applicability of electricity for traction purposes. It was concluded as immaterial whether the alternating or the continuous current were employed, but that in either case the motive power and mains should be kept distinct from those for lighting purposes. The last two questions dealt with the system to be adopted for Frankfort, but owing to certain details from the firms interested not being forthcoming, no decision in the matter could be given.

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No. of test.	Motor.		Third machine.						Results.			Remarks.
	Energy consumed.		Energy delivered.			Losses.			Efficiency of motor.			
	Degree on watt-meter.	Watts.	Volts.	Amperes.	Watts.	in the arma-ture.	in shunt circuit	Other losses.	Watts.	H.P.	Per cent-age of degree of effi-ciency.	
1	2	3	4	5	6	7	8	9	10	11	12	13
a	137.2 138,0 138,0 138,0 ...		98,3 98,4 98,3 98,3 98,3	188,0 188,0 187,0 187,0 187,0								Starting required, 30 seconds. Resistance in shunt circuit = 20·1 + 6 = 26·1 ohms.
	137,8	22 700 (30,8 H.P.)	98,32	187,4	18 400	530	370	700	20 000	27,2	88,1	
b	155,0 155,0 154,5		103,3 103,4 103,5 103,4	198,0 198,5 199,0 199,0								Resistance in shunt = 20·1 + 3 = 23·1 ohms. Third machine fed 20 series = 196 lamps.
				198,8 diff. + 1,0								
	154,8	25 500 (34,6 H.P.)	103,4	199,8	20 660	600	460	700	22 420	30,5	87,9	
c	118,5 118,5 118,5		101,0 100,5 100,5 101,0	156,0 155,0 155,0 155,0								Resistance in shunt = 20·1 + 7 = 27·1 ohms. Third machine energised 16 series = 156 lamps.
				155,25 diff. − 0,65								
	118,5	19 500 (26,5 H.P.)	100,75	154,60	15 580	360	370	700	17 010	23,2	87,3	
d	87,0 87,0 87,0		98,5 98,0 98,1 98,3	113,5 112,5 112,5 112,0								Resistance in shunt = 20·1 + 9 = 29·1 ohms. Third machine fed 12 series = 116 lamps.
				112,7 diff. − 1,4								
	87,0	14 330 (19,5 H.P.)	98,2	111,3	10 930	180	330	700	12 140	16,5	85,2	
e	68,0 68,0 68,0		101,4 102,0 101,5 101,8	80,0 80,0 80,0 80,0								Resistance in shunt = 20·1 + 12 = 32·1 ohms. Third machine fed 8 series = 76 lamps.
				80,0 diff. − 4,0								
	68,0	11 200 (15,2 H.P.)	101,7	76,0	7 730	95	325	700	8 850	12,1	79,0	
f	48,0 48,0 48,0		101,5 102,0 101,5 102,0	44,5 44,0 44,5 44,0								Resistance in shunt = 20·1 + 15 = 35·1 ohms. Third machine energised 5 series = 46 lamps.
				44,25 diff. − 3,00								
	48,0	7 900 (10,7 H.P.)	101,75	41,25	4 200	25	295	700	5 220	7,1	66,0	
g	22,0 22,0 22,0		103,5 103,5 104,0 104,0	0 0 0 0								Third machine free, but still magnetised. Resistance in shunt = 20·1 + 17 = 37·1 ohms.
	22,0	3 620 (4,9 H.P.)	103,75	...	...	...	290	700	990	1,35	27,5	
h	17,0 17,0											Free running—that is, third machine run conjointly, but not excited.
	17,0	2,800 (3,8 H.P.)	...	...	...	...	...	350	350	0,48	12,5	
	12,0 12,0											Belt thrown off. Run of the motor = 18secs.
	12,0	1 970 (2,7 H.P.)	...	...	...	...	...	...	...	...	...	

SECOND SERIES OF TESTS.

25 H.P. GANZ ALTERNATING-CURRENT MOTOR. *Free Running and Degree of Efficiency.*

No. of test.	Motor.		Third machine.						Results.			Remarks.
	Energy consumed.		Energy delivered.			Losses.			Efficiency of motor.			
	Degree on watt-meter.	Watts.	Volts.	Amperes.	Watts.	in the armature.	in shunt circuit	Other losses.	Watts.	H.P.	Per-centage of degree of efficiency.	
1	2	3	4	5	6	7	8	9	10	11	12	13
1a	183,0 183,0 183,0		110,0 111,2 111,4 111,4 111,4	211,0 211,0 213,5 214,0 214,0								Resistance in shunt circuit=20·1+1=21·1 ohms. Third machine fed 20 series=196 lamps.
	183,0	30 100 (41,0 H.P.)	111,1	212,7	23 630	670	590	750	25 640	34,8	85,5	
b	100,0 99,5 99,0		98,8 99,0 98,5 98,7	130,5 130,5 130,5 130,0								Resistance in shunt=20·1+8=28·1 ohms. Third machine energised 14 series=136 lamps.
				130,4 diff. – 1,0								
	99,5	16 400 (22,3 H.P.)	98,7	129,4	12 770	250	350	700	14 070	19,2	85,8	
c	63,5 63,0 63,2		99,7 99,9 99,8 99,5	77,0 76,0 76,0 76,0								Resistance in shunt=20·1+12=32·1 ohms. Third machine fed 8 series=75 lamps.
				76,25 diff. – 4,45								
	63,2	10 400 (14,2 H.P.)	99,7	71,80	7 160	75	310	700	8 245	11,2	79,4	
d	20,0 20,5 21,0		109,0 111,0 115,5 112,0	0 0 0 0								Third machine free, but excited. Resistance in shunt=20·1+15=35·1 ohms.
	20,5	3 380 (4,6 H.P.)	111,9	0	0	0	360	750	1 110	1,5	33,0	
e	15,0 15,0											Free running. Third machine not excited. *Bearings and air friction.
	15,0	2 470 (3,4 H.P.)	0	0	0	0	0	350*	350	0,48	14,0	
f	66,0 66,0 66,0		102,3 102,2 102,0 102,0	76,0 75,5 75,5 75,5								Resistance in shunt=20·1+12=32·1 ohms. Third machine fed 7 series+5=75 lamps. Degree of efficiency of third machine 87 per cent.
				75,6 diff. – 4,5								
	66,0	10 870 (14,8 H.P.)	102,1	71,1	7 260	75	325	700	8 360	11,3	76,7	
g	104,0 105,0		108,6 108,3 108,5	121,0 121,5 122,0								Resistance in shunt=20·1+7=27·1 ohms. Third machine energised 11 series+5=115 lamps. Efficiency of third machine =90½ per cent.
				121,5 diff. – 1,5								
	104,5	17 200 (23,3 H.P.)	108,5	120,0	13 000	215	435	750	14 400	19,6	83,7	
h	119,0 120,0		101,7 102,0 101,8 102,0	154,5 154,5 154,5 154,0								Resistance in shunt=20·1+7=27·1 ohms. Third machine fed 15 series+5=155 lamps. Efficiency of third machine=91½ per cent.
				154,4 diff. – 0,7								
	119,5	19,700 (26,8 H.P.)	101,9	153,7	15 660	360	380	700	17 100	23,3	86,9	
i	156,0 156,0 156,0		103,4 103,2 103,0 103,5	198,0 197,0 198,0 198,0								Resistance in shunt=20·1+3=23·1 ohms. Third machine energised 20 series=195 lamps. Degree of efficiency of third machine=92 per cent.
				197,75 diff. – 0,95								
	156,0	25 700 (34,9 H.P.)	103,3	196,8	20 330	570	460	700	22 060	30,0	86,0	

THE TESTS.

The tests of the machines and apparatus provided by the competing firms were conducted by the commissioners in the presence of the representatives of those interested, and took place in a provisional laboratory erected by the municipal architect close to the river. The observations were made and noted by the five members of the commission, and were immediately written down. Before each trial commenced the method to be adopted was considered, and suggestions from the representatives received, these being as far as possible adhered to. The notes made were collected by Mr. Lindley and then signed by the other members, the results of the calculations being fully expanded and presented to the commission at their meeting on February 2, when approval to the report was given.

At the outset a comparison of the measuring instruments to be used was made. The results were as follows:

	Hummel's No. 1 voltmeter.	Hummel's No. 2 voltmeter.	Cardew voltmeter.
	109·5	109·5	109·7
	109·6	109·5	109·5
	109·2	109·5	109·4
Average	109·4	109·5	109·5

It will be seen that the difference in the above is only about $\frac{1}{10}$ per cent.

Comparison of the Ganz Wattmeters.

	Ammeter.	Cardew voltmeter No. 1.	Wattmeter.
	10·97	106·6	101·0° (r)
	10·97	106·6	101·0 (l)
	10·95	105·5	101·0 (r)
Average	10·96	106·57	

Therefore the introduced effect: 10·96 × 106·57 = 1,168 watts. The resistance in the shunt coil: 1,348 ohms at 17deg. C. The constant of the wattmeters in this condition is 0·00857, and, according to Mr. Bláthy, 0·00831, the difference being about 3 per cent.

Comparison of the Voltmeters with Prof. Kittler's Torsion Galvanometer No. 1,766.

	Voltmeter (1)	Voltmeter (2)	Cardew voltmeter (1)
	109·5	109·2	109·3
	109·5	109·3	109·5
	109·5	109·2	109·3
	109·5	109·2	109·5
Average	109·5	109·23	109·4

With the torsion galvanometer, No. 1,766, of Siemens and Halske, the figures are 100·6deg., 100·6deg., 100·6deg., and 100·6deg., or an average of 100·6deg. The constant of the torsion galvanometer, according to Prof. Kittler, = 1·085. This gives = 109·1 volts. All four instruments thus agree up to a small fraction of 1 per cent. After this comparison, as the differences within the limits of defects lay in the tests, the apparatus were considered as accurate.

EXPLANATIONS OF THE SERIES OF TESTS NOS. 1 TO 5, AS SHOWN IN THE ACCOMPANYING TABLES.

The alternating current for the trials was furnished by a 10-pole Ganz alternator of the type A 5, No. 1,080, giving 50,000 watts at 2,000 volts at the terminals. This alternator was driven by a stationary locomotive boiler and engine of 50 normal h.p., made by R. Wolf, of Buckau-Magdeburg, the engine also actuating the D 1, No. 1,081, exciting dynamo. The engine at 120 revolutions would drive the alternator at 500 turns, thus causing the latter to have a period of 5,000 alternations per minute, but at the trials it averaged less than 119 revolutions, so that the alternations were only 4,940. The A 3, No. 1,081, 25 h.p. Ganz alternating-current motor was excited through transformers by a 25-volt converted low-tension current.

INTRODUCED EFFECT.

The introduced effect was measured through a wattmeter whose constant for the thin winding was 0·00831, and for the thick winding 0·0267 at 17deg. C. The motor was loaded through belting by a D 4, No. 1,108, constant-current dynamo by Ganz, and the current was used to feed a lamp battery comprising 200 glow lamps each of 32 nominal c.p., and which could be inserted or withdrawn in series of 10 lamps. Each lamp corresponded to about 100 watts at 100 volts pressure.

EFFICIENCY FURNISHED.

The delivered efficiency was measured through a No. 2,397 Hummel ammeter and by a voltmeter. The difference in the readings of the Hummel ammeter, as compared with a normal ammeter, is shown in the following table:

Normal ammeter	15	28	41
Reading of Hummel's ammeter	16	29·5	44
Difference	−1	−1·5	−3

58	71·5	85·5	91·5	116	143	170·5	195
63	76	88	91	118	143	172	194
−5	−4·5	−2·5	+0·5	−2	0	−1·5	+1

LOSSES IN THE THIRD MACHINE.

The degree of efficiency of the third machine was estimated by Mr. Bláthy at 91 per cent., and this degree was considered in the preliminary notes. In the final calculations the losses in the third machine were settled as follows: (*a*) The loss of efficiency in the armature was reckoned on the basis of the resistance at 0·015 ohm; (*b*) the loss of efficiency in the shunt coils on the basis of the resistance at 20·1 ohms, and by adding the inserted regulating resistance for the time being.

(*c*) The efficiency losses in the iron core and through bearings and air friction were taken—

At 100 volts pressure at the terminals of the third machine as	700 watts
At 110 volts " " " as	750 "
At 120 volts " " " as	800 "

and of this 350 watts are taken as bearings and air friction.

LOSS OF EFFICIENCY THROUGH DRIVING BY BELTING.

This loss in the trials 1h and 1i comes out at 2,800 − 350 − 1,970 = 480 watts. Accepting that 30 watts of this correspond to the loss by extra friction in the bearings of the motor, the efficiency loss by belting, including the extra loss due to friction in the bearings of the third machine, amounts to 450 watts = 0·6 h.p. This loss has been neglected, so that in columns 10 to 12 the stated effective performance of the motor is that which was exercised on the belt pulley of the third machine.

THIRD SERIES OF TESTS.

25 H.P. GANZ ALTERNATING-CURRENT MOTOR—*Sudden Unloading.*

The motor was set in motion and loaded with the whole of the lamp battery (195 lamps) at 110 volts pressure. According to the tests 1a, 1b, and 2i, this load corresponds to a useful performance of the motor of 35 effective h.p. —that is, taking the degree of efficiency of the alternating-current motor at 85 per cent. = 41 h.p. of introduced efficiency in the motor. In decreasing the load, seven series of lamps (65 lamps) were first suddenly withdrawn; then another seven series (70 lamps); and, lastly, six series (60 lamps) were switched out of circuit. Thus the load was reduced by thirds until the motor ran free. The result was that the motor continued its course and showed no interruption.

FOURTH SERIES OF TESTS—*Sudden Extra Loading.*

(The motor was started simultaneously with the third machine.)

Lamps suddenly switched in.	Corresponding to		The wattmeter rose suddenly to degree.	Corresponding to an effective performance of	
	Percentage of total load.	Effective horse-power.		Watts.	H. P.
1	2	3	4	5	6
7½ series = 75 lamps	About 40%	14	—	—	—
4 " = 40 "	" 20%	7	104°—105°	17,300	23·5
4 " = 40 "	" 20%	7	119°—120°	19,800	27·0
4 " = 40 "	" 20%	7	156°	25,800	35·0
195 "	" 100%	35			

The results of these tests were that the motor continued its regular course and showed no interruption. The trials were several times repeated in various combinations and successive series by suddenly inserting and withdrawing the load, and the same results were obtained.

Fifth Series of Tests.

25 H.P. Ganz Alternating-Current Motor—*Greatest Sudden Loading.*

(*a*) The motor was started simultaneously with the third machine. At first five series of lamps were so inserted that they were fed through the transformers direct from the primary machine. These five series were then suddenly thrown upon the third machine, and therefore upon the motor, and after running for some time the lamps were again fed through the transformers so that the motor ran free. The lamps inserted were then increased to 10 series, and this load was again suddenly transferred from the converters to the third machine and motor. Similarly the load was increased until the motor ceased its synchronism and came to a standstill. It was found that a load corresponding to 26 effective h.p. (17,500 watts) could be suddenly thrown upon the motor without the latter coming out of its regular course.

(*b*) The test of 26 h.p. was afterwards repeated.

The load was suddenly thrown on and off the motor, and simultaneous observations were made regarding the number of revolutions.

	Per minute.
The revolutions in regular running were with 26 h.p....	540
(1) The whole load was suddenly taken off and the number of turns increased to	545
And instantly fell to	540
(2) The whole load was then suddenly thrown on and the revolutions decreased to	536
And immediately rose to	540

The trial was repeated many times with the same result. The motor remained both on sudden loading and unloading within the above limits, and kept its regular course without losing its synchronism. The fluctuation in the number of revolutions which occurred in the primary machine and therefore in the motor through the change in the load was +0·92 and −0·74, the mean being therefore ±0·83 per cent.

ON ELECTRIC MOTORS IN GENERAL RAILWAY WORK.*

BY DR. LOUIS BELL.

(Continued from page 276.)

As it is now, then, the locomotive appears to be rather more economical than the average non-condensing single engine, but if the locomotive is ever pushed hard by any other motive power it will be developed in the direction of compounding. We have already enough tests of compound locomotives to form a pretty distinct idea of the saving that can be effected. In the series of experiments first tried in Russia several years ago to determine the efficiency of a compound locomotive the average of the results obtained shows that the horse-power hour was obtained with the evaporation of a little less than 25lb. of water. The indicated horse-power ranged from 160 to 260, and the mean saving in steam over ordinary locomotives was about 20 per cent. Some of the experiments gave the horse-power hour on less than 23lb. of water.

Reports from compound engines tried in India are not quite so favourable, the economy in fuel being only 13 per cent. A long series of tests of the Von Borries compound locomotives in Germany gave an average economy of fuel of 16 per cent., so that on the whole we must conclude that in the matter of efficiency the compound locomotive gives about the same results as any other compound non-condensing engine.

It would appear, then, that the saving of fuel effected in the electric system would practically be that due to the difference between condensing and non-condensing engines. The saving in fuel would probably be about one-half. The saving in employés would be comparatively small, as two or three men would be required to operate each power station.

The margin of economy, therefore, between an electric system and locomotives appears to be about enough to balance the losses in the transformation in the electric system. This latter, however, has two additional advantages that tend to economy. In the first place, a somewhat cheaper grade of coal can be used with a stationary engine, because better firing is possible. In the second place, an electric locomotive would have a decided advantage in the matter of weight efficiency which ensures a slight economy in power. I should say that an electric locomotive of the power we have been considering would weigh from 30 to 50 per cent. less than an ordinary locomotive with its tenders. One instinctively asks if this lighter weight does not mean decreased tractional power? And hence, does it not work to the disadvantage of the electric locomotive? This opens the question of the effect of using the rail return for the current which supplies the power. Most of those who have studied the subject think that the adhesion is somehow greatly increased by the passage of the current from the wheel to the rail. So far as I am aware, there are no experiments under anything like working conditions which give us a definite idea of the facts. That the general opinion is well founded, I have little doubt, and in looking over some of my note books I have found some experimental evidence. This was a fact well known, I presume, to others who have experimented on electric cars, that the ratio between the power required to start a car and that required to keep it in motion is quite out of proportion with the results one would expect, judging from dynamometer tests on ordinary street cars. I am of the opinion that the increase in adhesion even under ordinary working conditions, is very considerable. Where very heavy currents are used, we know from actual experiment that such is the case, as has been shown by Mr. Ries.

And this naturally raises the question as to the possibility of reaching very high speeds by the use of the electric locomotive. Of course in any case increased speed means greatly increased power, and the question then becomes one of comparative weight efficiency and adhesion. This comparison is certainly to the advantage of the electric motor; but we must remember that the limitations upon railway speeds to-day are not those set by mechanical difficulties, but by considerations of safety and economy, and these do not change in any marked degree with a change in the motive power. If it would pay to run railroad trains at an average speed of a mile a minute, it would have been done long ago, and there is no reason to expect that the use of electricity would quicken the running time unless the public demanded it, and felt quite safe and reassured at the prospect of being hurled through space at the rate of a hundred miles per hour, or thereabouts. If there should be an imperative demand for very high speed, I think one may roughly estimate that the use of electricity would nearly double the speeds now in use, but the question of these very high speeds is purely a question of dollars and cents, for, as a rule, very fast trains are not found to pay particularly well.

In the case of a suburban road the saving in wages would be considerable, since one power station would suffice for the whole system, and the same, of course, is true of any large system operated from a single station. The Illinois central suburban trains, for example, might be run electrically with great advantage to the public and probably to the company. Smaller and more frequent trains would work wonders in the suburban traffic, and the absence of smoke and dust would be a blessing to residents along the lake front.

I have been considering up to the present the sort of railroad work most unfavourable to electricity, that is, general work over long distances. There are, however, certain cases in which, even now, electricity could be employed to great advantage. For example, take railway lines between neighbouring cities, where the passenger traffic is large and frequent trains are run. If there were two competing roads, one operated by electricity and the other by steam, I should expect at least 50 per cent. more travel on the electric road, by reason of its freedom from dirt and smoke and attendant inconveniences. The same, I think, would be true in the case of very many suburban roads, and in these cases where the distances are comparatively short, I should expect lessened running expenses by the use of electricity. More especially would this be true if electric braking should ever be put into successful use. Up to the present, however, it has been one of the things very beautiful in theory and attractive in experiment, but which no one has cared to attempt employing.

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* Paper read before the Chicago Electric Club, March 17, 1890.

The case, however, where an electric system would work to the very best advantage is the elevated railroad. In such a case we have a compact system which could be supplied from a single power station in the most direct and economical way. The damage to neighbouring property would be enormously lessened, and the present objections to an elevated system would be in a great measure removed. Of the success and economy of an elevated electric system there can be no reasonable doubt, and I would go so far as to say that, in view of what can be accomplished by electricity, there is no reasonable excuse for permitting the use of ordinary locomotives on an elevated system. The question has never been properly agitated, but if it were, I can see but one possible result. The difficulties of running an elevated system by electricity are immensely less than those encountered in the operation of a great street car system, like that in Boston. In particular the bugaboo of electric railroad men—repairs—would dwindle into insignificance; for, lifted from the dirt and mud of the street, an electric motor can readily be given such care as would reduce the repairs to a comparatively small figure.

Let us look into the gain that could be made by using electricity on an elevated line. It is, I think, a peculiarly favourable case, and we, fortunately, have the facts and figures at hand to determine its probable advantages. I will put aside for the moment everything except considerations of economy and running expenses, and I will turn to the New York elevated system for our facts.

The locomotives on the Manhattan railroad work under conditions anything but favourable to economy. They are on duty 20 hours per day, and of that time steam is admitted into the cylinder but six hours. The full horse-power of the engine is 185, the mean horse-power is said to be 70·3, as a natural result of this the coal consumption is high, being 6·2lb. per horse-power hour. Now, let us count the cost of fuel for each engine, and we have an average consumption of 435lb. of coal per hour. What coal consumption will be required to furnish 70·3 mechanical h.p on an electric system of distribution? In the first place, we shall have the advantage of being able to use triple expansion condensing engines and the corresponding coal consumption is about 2lb. per horse-power hour. This would mean something like 15lb. of water, certainly a reasonable figure. I shall allow 125 i.h.p. to furnish the 70·3 h.p. required. This certainly is a liberal estimate, meaning as it does an efficiency of only 56 per cent. from engine to car. This allows 90 per cent. efficiency for the dynamos, 90 per cent. efficiency for line, and a little less than 70 per cent. commercial efficiency for the motors. This estimate is surely within safe limits, for if 90 per cent. is high for the line, surely 70 per cent. is low for the large motors, for at least this figure can be secured with a good street car motor.

Against then 435lb. per hour of coal required for the locomotive, we have 250lb. of coal per hour required to furnish the same power to the train electrically; and beside the coal required for the locomotive is of a higher grade than that which would be used with a stationary engine, for it has been found best on these small locomotives to use a rather high grade of coal, whereas I have estimated the coal consumption for the stationary engine on the basis of a cheap coal, having an evaporative power of 7 to 7·5 pounds of water per pound of coal, and costing less than 2dols. per ton in New York. Bearing in mind these figures, we see that the saving of fuel must mean considerable. The coal for the New York elevated road costs over 700,000dols. per year. In view of the facts I have just set forth, I think on a conservative estimate there will be a saving of 400,000dols. per year by generating the power at the central station and distributing it electrically. This means lessening the operating expenses of the system by a very perceptible amount. Aside from the bare cost of fuel, the saving and handling of coal and ashes and furnishing water will be no small item.

But even this great saving in operating expenses would not represent the saving which could be effected in operating a new elevated road by electricity. In the first place, the damage to adjoining property would be enormously lessened by avoiding the noise, smoke, and dirt of a locomotive. In fact, I believe that the saving in the cost of right of way would go far toward paying the expenses of equipping the road electrically. But this is not all. The use of locomotives makes necessary the use of larger train units. Larger train units mean, on the score of safety, running at rather less frequent intervals, and that in turn means giving up that as yet unrealised ideal of rapid transit, small trains running at such frequent intervals that it would never be worth while to run for one. With lighter trains running at more frequent intervals, the strain on the supporting structure would be greatly lessened, and the load more uniformly distributed, consequently the whole structure would be made light in appearance and reality, costing considerably less, and being far less unsightly than those now in use.

(*To be concluded.*)

NEW COMPANIES REGISTERED.

Andrews and Preece, Limited.—Registered by Waterlow Brothers and Layton, Limited, with a capital of £25,000 in £10 shares. Object: to acquire the business of Andrews and Preece, electrical engineers, of Bradford, Yorks., and to develop and extend the same. The first subscribers are:

	Shares.
T. R. Andrews, Fountain Villa, Horton-lane, Bradford	1
T. Preece, St. Andrew's-villas, Bradford	1
H. Hanson, Thornleigh, Apperley	1
J. H. Murgatroyd, Savill Lawn, Halifax	1
W. B. Brayshaw, 26, Leamington-street, Manningham	1
R. C. Douglas, 1, Cunliff-villas, Manningham	1
J. Duff, Ivegate-chambers, Bradford	1

Registered without articles of association.

CITY NOTES.

Direct Spanish Telegraph Company.—The estimated receipts for March were £2,382, against £2,129.

West Coast of America Telegraph Company.—The receipts for the month of March amounted to £4,400.

Brazilian Submarine Telegraph Company.—The receipts for the week ended April 4 amounted to £4,134.

Great Northern Telegraph Company.—The receipts for March were £20,800, making a total from January 1 of £60,200.

Eastern Telegraph Company.—The traffic receipts for March were £58,471, as against £55,987 for the same period of 1889, or an increase of £2,484.

Eastern Extension Telegraph Company.—This Company's traffic receipts for the month of March were £41,133, as against £42,896 for the same period of 1889.

Cuba Submarine Telegraph Company.—The estimated receipts for March were £4,000, as compared with £4,540. The receipts for December, estimated at £3,000, realised £2,995.

West India and Panama Telegraph Company.—The estimated receipts for the half-month ended March 31 are £3,763, against £3,742. The December receipts, estimated at £5,446, realised £5,540.

Western and Brazilian Telegraph Company, Limited.—The receipts for the week ended April 4, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,172.

Oriental Telephone Company, Limited.—The Directors of this Company have resolved, subject to final audit of the accounts, to recommend to the shareholders a dividend of 3 per cent., free of income tax, on the paid-up capital of the Company, other than the vendors' shares, for the year ending December 31 last, to place £2,000 to reserve, and write off £850 for depreciation, etc. The balance to be carried forward will be about £1,200.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Anglo-American Brush	—	2½
— Pref.	—	1⅞
India Rubber, Gutta Percha & Telegraph Co.	10	18
House-to-House	4½	5
Metropolitan Electric Supply	—	5¾
London Electric Supply	5	2⅞
Swan United	3½	5
Crompton & Co., Pref.	—	5½
National Telephone	5	5¼

NOTES.

Passengers.—It is estimated that 150,000,000 passengers a year are now being carried by electric roads in America.

Bromley.—The Bromley Local Board have appointed a committee to report upon the question of lighting the town by electricity.

Acton.—The promoters of the Acton and Ealing Electric Light Company have written informing the Board that for this year the Bill seeking the necessary powers had been withdrawn.

Inverary Castle.—The seat of the Duke of Argyll, Inverary Castle, has been fitted up with the electric light, the dynamos for its production being worked entirely by the river and waterfall near the castle.

Coal in Kent.—A paper will be read before the Society of Arts on Wednesday evening next on "Coal in the South-East of England," by William Whittaker, F.R.S. Archibald Geikie, LL.D., F.R.S., will preside.

Institution.—On Thursday next, 24th April, a paper will be read before the Institution of Electrical Engineers by Dr. Oliver Lodge "On a Lightning Guard for Telegraph Purposes, and on the Protection of Cables from Lightning."

Utilising the Rhine.—The question of utilising the power of the falls of the Rhine at Winterthur is well advanced. The engineers expect to realise 1,500 h.p. to be transmitted electrically for motive power and for smelting operations.

Marriage.—Mr. C. P. Sparks, partner of Messrs. S. Z. de Ferranti, was married on Thursday week to Miss Mabel Thacker. We tender our best wishes to the happy pair, who, we hear, have gone to Switzerland to spend the honeymoon.

Alnwick Castle.—Electric light has been installed at Alnwick Castle under the superintendence of Mr. W. Attwater. The dynamo is driven by a turbine, and storage cells are also employed. Some 80 miles of wire and cable have been used.

Engineers' Tools.—We have received a very complete catalogue of engineers' tools, lathes, shaping machines and drills, from the Britannia Company, Colchester, which those about to extend their works or start engineering operations would do well to send for.

Aluminium.—Large aluminium works are to be erected at Corry, Pennsylvania, by a Chicago company. It is intended to use the electric process. Work will be begun in May, and the company is under bonds to expend at least 50,000 dols. on its works the coming season.

Raw Hide Gear.—A regular industry is being started in America in the manufacture of gearing for electric railways out of raw hide. They are preferred to metal, as they make far less noise and wear better. The material is said to finish up in the working as well as metal.

French Exhibition.—The French Exhibition at Earl's Court and West Brompton will be opened at 3 p.m. on Saturday, May 10th, by the Lord Mayor. The French Committee are of opinion that this will be the most representative display of arts and industries yet made by France abroad.

Academy of Sciences.—The death of Kirchoff having created a vacancy in the group of foreign corresponding members of the French Academy of Sciences, an election to fill the place was recently taken. Lord Rayleigh having received 42 votes against two for M. Louis Soret was accordingly elected.

Overhead Wires.—The Rotherhithe Vestry have adopted the resolution that the Vestry petition Parliament against the Bill promoted by the London County Council in favour of constructing subways in which to place telegraph and electric light wires, in order that the Vestry may secure certain amendments.

Alternate Motors in Italy.—The first alternate-current motor in Italy has just been started at Alzano Maggiore, where a motor of 5 h.p. has been used to drive a centrifugal pump. The motor appears to be running exceedingly well, works at a high efficiency, without sparking and with perfect regularity of speed.

Telephone to the Mumbles.—The telephone has now been extended from Swansea to the residential suburb known as the Mumbles, and will be a great convenience to a large number of professional and business men that reside there. The charge for three minutes' conversation with the nearer towns is 6d., and 1s. for greater distances.

New Firm.—Messrs. Ross, Courtney, and Co. have established themselves at Ockenden Works, Ockenden-road, Dalston Junction, as electrical and general engineers and contractors, and as such intend undertaking also the manufacture of fittings, electrical or mechanical, repairs to plant, manufacture of special machines, or new inventions.

Craig-y-nos.—Madame Adelina Patti's private theatre and winter gardens at her Welsh residence, Craig-y-nos Castle, are being lighted with the electric light, the installation of which has been entrusted to the Wenham Company, Limited, of London, the whole of the work being carried out by their own staff in the electrical department

Canterbury.—A proposal for the introduction of the electric light into Canterbury has been favourably entertained by the Town Council. The Mayor stated that the cathedral authorities were dissatisfied with the present system of lighting, and it was probable also that the electric light would be adopted at the Jesuit college and the barracks.

West End Electric Road.—It is said that the Boston (U.S.) West End electric road is already saving 40 per cent. in working expenses over the old method of horse power. It is stated that the company will have 9,500 additional horse-power before Nov. 1. The feeders will then be put underground, which will obviate the difficulties arising from their coming in contact with other wires.

Meter Tests.—Some careful tests are being taken by the official inspector for the Liverpool Corporation in conjunction with Mr. A. B. Holmes, M.I.C.E., of the Liverpool Electric Supply Company, of Hookham's electric meter. The tests are being carried out with much minuteness, and carefully arranged to check the results by all methods. Several of the details present points of novelty, and are ingenious adaptations of the old principles for the purpose.

Kent.—An installation has been completed at the new patent glue and gum works of the Belvedere Company, Belvedere, Kent. The plant comprises two dynamos, arc and incandescent, nine 8-ampere arc lamps, and 110 16-c.p. lamps, 110 volts. The whole of the plant was supplied by Messrs. Crompton, and the installation was carried out by Mr. Ernest G. Pink. The electric light has been much appreciated in the district owing to the entire absence of gas in many places.

Chamber of Commerce.—The annual meeting of the Electrical Trades Section of the London Chamber of Commerce will be held at the offices, Botolph House, Eastcheap, on Monday next, the 21st inst., at 4 p.m. The following is the agenda: (1) election of chairman and deputy-chairman; (2) election of committee; (3) labour conciliation scheme-proposed electrical trades committee; (4) International Exhibition of Mining and Metallurgy, 1890, (Crystal Palace).

Overhead Conduits.—Handsome posts carrying iron pipes to act as conduits for electric wires are now being proposed for American cities. Nothing in the nature of architectural or wrought-iron ornamentation would, however, get over the obtrusive features of large piping ramifying in all directions above the footwalks. The method is brought forward in all seriousness and has been patented, and it is stated there is much likelihood for it to be introduced in some of the towns in the United States.

Electrical Medical Lantern.—Prof. Stricker, of Vienna, will submit to the Congress on Internal Medicine, now being held at Vienna, a new electrical lantern which will be of great service to lecturers and medical students. By an ingenious combination of lenses, Prof. Stricker contrives to project the magnified images of objects on a white screen in their natural colours, so that, for instance, a small pimple on a patient can be shown in its real appearance to an audience of many hundred students. One of the experiments will be a demonstration of the palpitations of the heart of a small animal.

Deposition of Brass.—Treating upon the electrolysis of a mixture of two salts in aqueous solution, M. L. Boullevigne finds, using a mixture of Zn and Cu salts, that the composition of the brass deposited varies rapidly with the intensity of the current, contrary to Buff's law. Considering the variation to be due to the chemical action of the sulphate of copper upon the zinc in the alloy deposited, and that the amount of this action is proportional to the time, an expression is found which allows the composition of the alloy obtained with any given current to be determined with a fair degree of accuracy.

Wandsworth District.—A special meeting of the Wandsworth District Board was held last week for the purpose of giving the consent of the Board to the application of the House-to-House Electric Light Supply Company, Limited, for a provisional order authorising the company to construct and maintain electric lines and works and to supply electricity within the district of the Board. The clerk stated that the consent of the Board was given to the introduction of the provisional order, subject to certain streets being introduced, and that had been done. Upon the motion of Mr. Lidiard, the Board agreed to seal such order.

Chatham.—At a meeting of the Chatham Board of Health on Friday, 11th inst., a deputation, consisting of Mr. Jasper, Mr. Norman, and Mr. Wingent, waited upon the Board and requested that there should be a removal of the limitation to the consent as to the granting the electric lighting company a provisional order. The limitation fixed the period during which the company should carry on operations at 21 years, and the deputation wished that there should either be an absolute withdrawal or an extension of the limitation to 42 years, as provided by the Act of 1888. The Board referred the consideration of the matter to a committee.

Jumbo Dynamos.—Vastly less space is taken up in the reconstructed Edison station at Pearl-street, New York, by the new plant than by the old. The plant now consists of four Edison dynamos of 1,400 lamps nominal capacity, four of 850 lamps capacity each, and one of the old Jumbo dynamos coupled direct to a 150 h.p. Armington and Sims engine, having a capacity of 1,500 lights. Much of the saving of space is due to the substitution of new types of machines in place of the old Jumbo machines previously in use in the station. Of these machines, the one now in use was the only survivor of the fire, and it was so injured as to have to undergo repairs almost amounting to reconstruction.

Strength of Electric Welds.—The North Hudson County Railway Company, Hoboken, New Jersey, recently gave a testimonial to the Thomson Electric Welding Company, stating that they had subjected the piece of 1⅜in. steel cable made by Cooper, Hewitt, and Co., of the lock-wire pattern, welded by the Thomson Company, to the following tests: "We doubled the piece of cable backward and forward 130 times upon itself; then we put the weld between two pieces of iron on an anvil and gave it 10 or 12 smart blows with a 12lb. hammer; after that we bent it again 10 times both ways. The weld did not start and did not show any change." This seems to be a very good piece of evidence as to the efficacy of the electric weld.

Accumulator Patents.—The infringement suit of the Brush Electric Company against the Julien Electric Company of New York, which was brought some two and a half years ago, was decided by Judge Cox on the 14th ult. The decision was in favour of the Brush Company, although it is understood that the parties had come to a mutual understanding before the settlement of the suit—a curious illustration of the futility of lawsuits. This is the more the case that the suit between the Brush Company and the Electric Accumulator Company is still pending, but the decision would seem to give the Brush interests a point of vantage over the Faure patents. Meanwhile we suppose accumulators are desired, and are being made exactly as of yore.

N.Y. "Electrical Engineer."—The first weekly issue of the New York *Electrical Engineer* has come to hand, and in it Mr. Franklin Leonard Pope makes his farewell bow in handing over the reins which, taken (as he says) at first with reluctance, he has carried on in so high a scientific spirit during the last five years. With its 100th number the paper appears weekly under the new editors, Messrs. Martin and Wetzler. The first number is a bulky issue of 56 pages of matter. It contains three pages of leaders or leading notes—always an interesting feature—and an increasing number of cuts illustrative of American progress. To the usual scientific, legal, and patent office notes, a trade notes, novelties, and mechanical department is added.

Scarborough.—The minutes of the Electric Lighting Sub-Committee of the Scarborough Town Council showed that a letter had been received from the Board of Trade requesting to be informed what steps had been taken by the Corporation to give effect to the powers contained in their provisional order, or, if no such steps had yet been taken, to be furnished with some further assurance as to the time within which the Corporation are prepared to commence the supply of electric energy under their order.

The sub-committee had resolved that the Board of Trade be informed that the Corporation are prepared to undertake to put in force the powers contained in their provisional order within a period of 12 months. This action had received the confirmation of the full committee.

Board of Trade at Deptford.—A deputation from the Board of Trade, including Captain Cardew, went down to Deptford on Monday to witness some extremely interesting experiments with the 10,000-volt Ferranti mains. The Board of Trade have put forward an objection that in case of a workman cutting the wire the act would be dangerous to life. This was denied by the engineers, and the experiment was carried out to demonstrate that it was not the case. A length of the main was charged with the 10,000-volt current, and the main was then cut through with a hammer and a smith's sett. This was done in front of the visitors, without the slightest effect upon the workman who held the tools. The main was of course short-circuited, and the fuse at the other end went, but otherwise there was no accident.

Utilisation of Niagara.—The Niagara water-power tunnel, as designed by the late Mr. Thomas Evershed, C.E., is now said to be an assured fact, through the Cataract Construction Co., organised under the laws of the State of New Jersey. The plan proposes a tunnel about 200ft. long driven at right angles to the river at a point about one mile above the Falls, when a head of 120ft. is secured. From this intake a tunnel will run parallel to the river, and 400ft. from it, about 100ft. below the surface of water and connected with the river by conduits or lateral tunnels. The mouth of this tunnel will be immediately north of the State Reservation, and the area of the main tunnel will be equivalent to a circular, smooth tunnel 24ft. in diameter. The tunnel will have a descent for its last half mile of one in 100. The mills will be on the lateral conduits and the tunnel will carry off the tail-water.

The Passionate Electrician.—The following amusing rhapsody (inscribed to Lord Bury) was recently printed in the *Scots Observer*, embodying some of the ideas so generously showered down by correspondents of the *Times*:

Sweet, shall we volt it? Dearest, shall we ohm
Our wingèd way across the ocean foam?
Or were it fairer to electricize
(Or electrate) our path to happier skies?
What's in a name when all roads lead to Rome?
Fairest and rarest under heaven's high dome,
O shall we squirm, or watt, or electrome?
Or, if you feel you'd rather not volize,
        Sweet, shall we volt?
Heart of my heart, no fond and frolic tome
But the grave *Times*, that motal metronome,
Bids us coulomb, or spark, or motorise.
And now I think of it the blue day dies?
'Tis time, 'tis time, that we were moting home—
        Sweet, shall we volt?

An Electric Roundabout.—We mentioned some time ago that some electric horses were being constructed by one of the electric companies of Paris. These have now been fitted up in a public place of amusement in Nice, where electricity is largely employed, not only in arc and incandescent lighting, but in the transmission of force to an electric roundabout or racecourse, consisting of ponies the size of life, the arrangement of M. Sallé. Each horse contains a motor, current being supplied by the rails. The weight to be drawn, including the rider, is about 5cwt., and the speed is about 600ft. per minute. The motors are supplied in parallel from a Rechniewski dynamo of 5,700 watts. The track comprises six circular and concentric lines, on each of which runs an electric pony. In this space the wooden coursers and their jockeys can move partly by their own will and partly by hazard, and the game is conducted and bets are made under the same rules as with the ordinary game of racehorses.

Electrolin.—A remarkable discovery is being mentioned in the German papers which has caused a considerable amount of animated comment. As far as we can make out it is supposed to be a new compound, a liquid, which on being poured into a battery supplies an electric current, the electrodes not being attached—in effect, an active electric solution which can be carried about in liquid form. It has been stated, we do not know with what amount of basis, that the concession has been offered in London for some enormous sum like a million sterling. A certain Marx, a chemist employed in the oil-lamp works of Wensky and Steinbrink, seems to be the primary author, and Mr. A. Edward Barthel, of New York, seems to be actively moving in the matter, Messrs. Tudor having received a curious letter from the latter asking them to come to Berlin, and to have 250,000 marks in cash ready. Messrs. Muller and Einbeck and Schuckert and Co. have also been approached, but with no result. It is understood that communications and visits have also been made to certain English electrical engineers. We mention the matter, but it must evidently be received with caution in default of definite information.

St. James's Vestry.—At the meeting on the 10th inst., the Lighting Committee reported with reference to a letter from the Board of Trade, transmitting for the observations of the Vestry a copy of the St. James's provisional order, in the form in which they propose to issue it, that as time presses they have informed the Board of Trade that the order generally carries into effect the terms agreed between the undertakers and the Vestry, but the committee regret that the Board have retained 14th clause, and references to the County Council in some other clauses, which the committee fear may, by creating concurrent jurisdiction, cause a regrettable conflict of authority between the London County Council and the Vestry, and that they have again suggested the desirability of omitting or altering 84th and 86th clauses, relating to bridges, embankments, and open spaces, to meet the circumstances of the case, as it is the intention of the Vestry to restrict the operations of the undertakers to this parish, and the existence of these clauses may at some future time be urged as an argument that an extension of operations was contemplated when the order was made, the exact contrary being the case. The report was adopted.

The Short Series System.—An important contract has recently been signed for electric cars in the town of Rochester, New York. The new street railway company of that town has, after considerable investigation on the subject of electric tramcar traction, decided to adopt the Short series system for their entire line. This is specially interesting as being the first large road in America to be worked upon the Short system. The contract is a very large one, being for 200 15 h.p. motors, and dynamos aggregating 1,100 h.p. The motors are to be placed on 100 cars of the vestibule pattern, 16ft. long, each fitted with two of the Short motors. All the old rails are to be taken up, and new steel rails of the latest pattern are to be laid. The line will be mostly double-track. The old cars will be sold, and the entire system changed to an electric road with most modern improvements. The entire cost will not be less than two million dollars. The Short system has been taken up by Brush interests, and the progress of this line will be watched with great interest by other companies, as the radical change in principle from the usual parallel working denotes a change which may possibly have far-reaching results, while the possibilities of the system will now have the opportunity to be amply demonstrated.

Deptford.—Further reports of the failure, past, present, or future, of the Deptford station continue to be rumoured, and, we suppose, will until the station is entirely opened. As a matter of fact, the Deptford station is working now, and has been working practically every day since November last, supplying current for the Grosvenor circuit—at half pressure, but usually full current—Deptford working as a reserve to the Grosvenor plant. A second engine is now erected, and sundry small improvements are being introduced into the second dynamo before starting. The reports of the failure of the Ferranti mains are devoid of any foundation. Recently a length of main, consisting of some 30 or 40 lengths, and extending round the Deptford station, was tested with transformers up to 18,900 volts without failure. The mains are considered quite satisfactory, and tons of the lengths are being manufactured. Some miles are already laid along the route in different parts. Although more time has been taken than has been expected, yet it is sufficiently noteworthy that, with the exception of enclosing the mains to satisfy certain authorities, the work at Deptford has all been carried out as originally proposed and determined, and the engineers avow themselves thoroughly satisfied with the result both of the dynamos and the mains.

The Silvertown Dry Cell.—A new cell has been introduced by the India Rubber, Gutta Percha, and Telegraph Works Company, of Silvertown. It is a dry cell, specially designed for use where the battery is liable to shaking, or rough handling, such as on board ship, for field telegraphy, and similar work, where it would be found inconvenient to use the ordinary cells. As the cell is self-contained, and delivered ready for use, it is only necessary to couple it up in the usual way, when required, no solution need be added. It is stated to possess all the advantages of the Leclanché cell, with the additional advantage that it may be used in almost any position, there being no liquid in it to spill. Care should be taken in mounting a battery of these cells to prevent one cell from touching another, and they should stand upon a base of some insulating material, such as glass or dry wood, and for efficient working this cell is not recommended to be used in positions where the temperature is high. When the cell appears to have been worked out it is, as a rule, only necessary to fill it up with a saturated solution of salammoniac and let it stand for some time, when the solution may be poured out and the cell wiped dry at the top; it will then be found to have recovered. It may be expected to prove an extremely serviceable cell, both for ordinary use and for testing.

Alternate-Current Motors.—The invention of alternate-current motors and the construction of the practical type for ordinary use is the great race to which electrical engineers are setting themselves at the present moment, and there is no doubt that the successful inventor, and more perhaps, the successful manufacturer, will have a rich prize before him. For electric central stations are springing up in all directions, using alternate currents for lighting, and the field for motors for these circuits will be a large one. We have already noted that the Tesla motor has been practically applied by Westinghouse in America for driving coal cutters. Mordey has shown that his alternate dynamos will act as motors, and has proposed certain practical suggestions for use, and though we are not aware of any actual employment this may be expected. Mr. Swinburne has been engaged in the same field with considerable success, if we may judge from the patent records. Messrs. Ganz and Co., as we have indicated, have overcome the great difficulty in the flashing of the brushes, and the tests published show that practical working is becoming possible. We now hear from Paris that a new alternate-current motor has been invented there and patented, strictly original in its features, and independent of synchronism in working. The electrical world will await with interest the practical developments that are sure in a short time to ensue from the intense activity in this field.

Rating of Machinery.—A Bill has been introduced into Parliament by Mr. Winterbotham to regulate the rating of machinery, which, on Wednesday, was read a second time, after a keen debate. The Bill is intended to fix the species of machinery that may or may not be included in the rateable value of premises. It has long been held that fixed machinery, which is in some sense a part of the premises, is liable to rates; but for many years machinery which was in no sense part of the building was held to be exempt from rating as much as other tools. A dozen years ago, it appears, Sir Alexander Cockburn decided that machines which make the premises fit for the purpose for which they are used are rateable, and Lord Esher more lately decided in the same sense. The result is that all over the country manufacturers have found themselves subject to a new burden, and in the words of the preamble of the Bill, "questions have from time to time arisen as to how far machinery is to be taken into consideration in estimating the rateable value of the premises in which any trade, business, or manufacture is carried on." The Bill consequently restores the law to the condition which existed before the decisions of Chief Justice Cockburn and Lord Esher. It enacts that the annual value of "water wheels, steam, gas, air, and electric engines, and all other fixed motive powers, and the fixed appurtenances thereof," with "shafts, wheels, drums, and other fixed power machinery which transmits the action of motive power," shall be considered in fixing the rateable value of premises, but that all other machinery, whether attached to the premises or not, shall be exempt.

Destruction of Telephone Wires.—At the Woolwich police court on Tuesday, four lads were charged on remand with stealing copper wire to the value of £2. 10s., the property of the National Telephone Company. The evidence showed that for months past serious damage had been done to the telephone wires on Cox's-mount, at Charlton, the wire being violently torn from the posts and carried away, thereby causing a heavy loss to the company and much annoyance to the public. The police kept close watch during the Easter holidays, and succeeded in arresting the prisoners, all of whom confessed to having thrown a rope over the wires and dragged them down. They broke the wire up, and sold it to two marine store dealers. Mr. Marsham said the prisoners had caused an amount of injury out of all proportion to their gain, and he must make an example to keep others from the like temptation. One lad, being very young, would be discharged; but the others would be sentenced each to six strokes with a birch rod. The parents of the boys were invited to witness the punishment, which was inflicted by the gaoler in the station-yard. The two marine store dealers, Mary Ann Dandridge, of High-street, and Jane Town, of Morris-street, Woolwich, were then called to answer summonses charging them with purchasing less quantities of copper than 56lb., contrary to the Prevention of Crimes Act, 1871. One of the boys was called to testify against them, and they both admitted that they might have bought small quantities of the wire and forgotten the circumstance. Mrs. Town also pleaded that she had been only a short time in the business and did not know the law, while Mrs. Dandridge said she had kept shop for 30 years without a complaint. Mr. Marsham fined Mrs. Town £2, and Mrs. Dandridge £3.

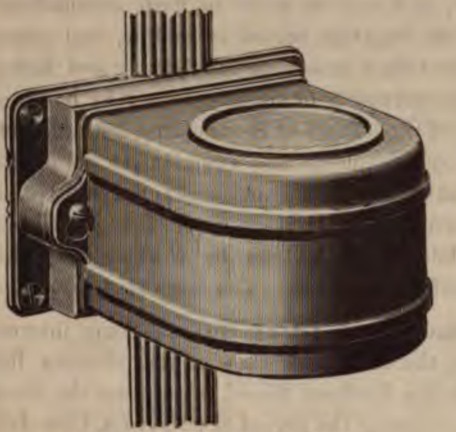
Commissioners of Sewers at Taunton.—The directors of the Taunton Electric Lighting Company must be becoming quite proud of their installation. Not only are they able to pay good dividends and to say they have converted nearly everyone in Taunton to the side of electric lighting, but their town has become quite a place of pilgrimage for city corporations and other authorities requiring information as to how to do likewise. On Friday last a deputation, consisting of 10 members and the clerk to the Honourable Commissioners of Sewers of London, accompanied by their engineer and Mr. W. H. Preece, F.R.S., visited Taunton for the purpose of inspecting the system of public lighting in operation there. They arrived at Taunton Station at six o'clock, having travelled by the fast train leaving Paddington shortly after two, and were met at the station by Mr. Massingham (managing director of the Taunton Electric Lighting Company), Mr. Wharton (of the firm of Laing, Wharton, and Down, who have the sole right in England of the Thomson-Houston system, the system used in Taunton), and Mr. J. H. Smith (the borough surveyor). Three landaus were in readiness, and the party were at once driven to the Castle Hotel, their headquarters during their stay, whence, after a short rest, they set out for the central electric lighting station in St. James's-street. There they were met by the engineer-in-charge and the staff, and were shown the various electrical and other machinery at work. They appeared very much pleased with all they saw. Afterwards they returned to the Castle Hotel, where they partook of a banquet at the invitation of the chairman and directors of the Taunton Electric Lighting Company, with the Mayor and members of the Taunton Corporation.

Electric Fog-Lights.—The system of electric fog-lights introduced on the Long Island steamers "Massachusetts" and "Rhode Island" appear to have proved very successful, and have inaugurated a new method of employing the electric light for fog signalling. The arc light on the steamboats is pointed vertically upwards, and the loom of the light rises to an incredible distance, being plainly visible at many times the distance at which a plain arc lamp could be seen. Pilots have reported seeing the light at 18 miles distance. The column of light resembles a stream of water thrown from a hose. Hitherto vessels have been fitted with search-lights to throw beams horizontally so as to distinguish approaching danger, but pilots say such lights are useless in thick weather, as no light can penetrate a thick fog horizontally. They are worse than useless and blind the men in the pilot-house. On the other hand, a light projected vertically in the direction in which the fog is least thick, will throw a loom fixing the position of the vessel. This search-light has been combined with a foghorn on the "Rhode Island" steamer, where the projector is placed on the top of the pilot-house, and is connected with the regular incandescent system of the boat. Then, by means of a weight that may be operated by a magnet, the steam foghorn of the vessel is brought under the control of the electric current. In the pilot-house there are four switches controlling the current that runs to the search-light and the foghorn, and by means of these switches the pilot can start the search-light so that it will flash at regular intervals automatically; or it may be made to burn steadily, or it may be made to flash automatically at the instant the foghorn begins to bellow, and cease to flash when the bellow ceases, or the flashing and bellowing may be done alternately or simultaneously by hand. It is the opinion of the officers of the line that nothing yet invented will be so valuable as this combination in preventing collisions at sea. This search-light weighs but 130lb. It occupies a deck space 2ft. square. It is placed in the top of the pilot-house, and can be worked from within and depressed to any angle. The lamp is of 3,000 c.p.

Incandescent Lamp Data.—Some interesting data covering the comparative cost of incandescent lighting are given in the *Electrical World*, taken from the carefully-kept records covering the period of two years, from Jan. 1, 1888, to Dec. 31, 1889, of the large isolated incandescent electric lighting plant in the basement of a well-known office building. The total dynamo capacity of the plant is 2,100 16-c.p. lamps; but 2,900 lamps have been wired in circuit, though a greater number than 2,000 lamps have been in actual use at one time only on two or three occasions. The plant has been in constant operation during every hour of the 24 months, with two exceptions, the first of less than two minutes, and the second of several hours, while some change in the position of the shafting was being made. Only two armatures were injured during the 24 months, necessitating a total expenditure of £53 to repair same. The total number of lamp hours for 1889 was 8,831,435, and for 1888, 8,353,080 hours, making a total of 17,184,515 hours. The comparative life of the lamps used during 1888 was found to be 3,250 hours, while this average had increased during 1889 to 4,464 hours. As the lamps used were all furnished by one company, the natural inference is that a higher grade of lamp is now being supplied, more especially as during the month of November, 1889, the comparative average life of the lamp has reached the high figure of 5,629 hours. The total amount of coal consumed during 1888 was 1,337 tons, and during 1889 1,406 tons, and for each pound of coal consumed a lamp was maintained for an average period of two hours 48 minutes. The average cost of maintaining a 16-c.p. lamp for 24 hours during the period mentioned was 3·41d. The cost during the first month of the period, January, 1888, was 4·48d. per each day of 24 hours, but careful management had reduced that cost by November, 1889, to 2·9d. per lamp for 24 hours. A careful study of the above abstract should convince every owner of an office building that it will be to his interest to have an electric light plant installed, with a view of furnishing electric light free to his patrons as an inducement to occupy his offices, as the total yearly average cost per lamp in a modern office building should not exceed 17s. per year per light, including every possible expense, aside from electric or combination fixtures, owing to the limited necessity for artificial light during the gre
the time the tenants are in their office

CARDEW EARTHING DEVICE.

Messrs. Drake and Gorham have considerably modified and improved the Cardew automatic earthing device. We give herewith illustrations of the latest perfected pattern which has been finally adopted by the London Electric Supply Corporation after an exhaustive series of tests, and will shortly be in use over all their London circuits. The necessity for apparatus of this class was foreseen by Major Cardew some time back, and his patents, which are held by Messrs. Drake and Gorham, cover devices which depend for their action on static attraction, or made on the Geissler tube or similar principles.

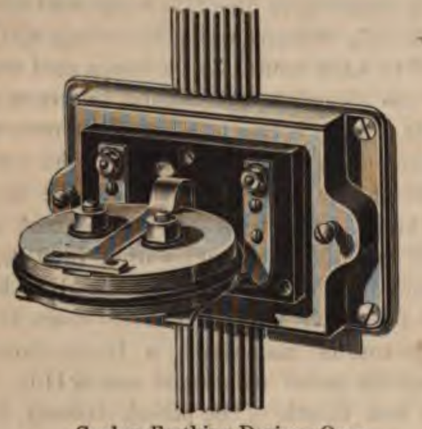


Cardew Earthing Device—Closed.

The static arrangement has been found to give the best results, and has been adopted in the standard instrument as being less liable to derangement.

The action of the device is to connect the secondary circuit to earth automatically whenever a dangerous difference of potential is established between the lamp circuit and earth. This result is obtained by interposing some medium which will be of infinite resistance until a high voltage exists, when a free passage for the current is provided.

The static device illustrated consists of two brass plates placed near, but insulated from, each other. Between these lies a thin foil of aluminium, which is retained in position by ebonite pegs, one plate being connected to earth and the other to the secondary circuit.



Cardew Earthing Device—Open.

A flat projection is formed on the upper plate over one end of the foil, so that as soon as a difference of 400 volts is established one end of the foil lifts by static attraction, and a metallic contact is made between the two plates. The main primary fuses are immediately severed by the increase of current, and the supply is cut off.

The two plates are insulated by ebonite rings, and are securely bolted together, so that after being tested at the central station no skilled labour is required to fix them. It has been shown that the plates can be shaken or rolled about without affecting the voltage at which the foil will lift.

The plates are carried by brass springs, to which the connections are permanently made at the back of a solid block of ebonite, so that the act of sliding in the plates makes the connections, and a slot on one side renders it impossible to put them in with the wrong side uppermost.

The plates are all made interchangeable, so that when the foil has acted it is merely necessary to slide in some fresh plates.

It has been suggested that the connecting of the secondary circuit permanently to earth will remove the necessity for this device, but there is no comparison from a fire risk point of view, for a strain is permanently put on the insulation of the conductors, and a slight leak which, with the automatic device would remain harmless for years, is liable to be developed at any time into a state of danger. This is especially the case in damp situations, where the size of the conductor may be reduced by corrosion.

It is evident that the apparatus can be modified to act as a relay and cut off both poles of the circuit, or to ring a bell and drop a danger disc, as has been arranged for the Chelsea Electric Supply Company, where continuous currents are used.

In addition to the Deptford Company, the instruments have been supplied to the Newcastle Electric Supply Company, the central station at Lynmouth, Devon, the Shanghai Electric Company, etc.

CONSTANT POTENTIAL WITH OVER-COMPOUNDED DYNAMOS.

BY ALEX. DOW.

The ideal constant potential distribution is that which maintains at the terminals of the lamp, motor, transformer or other translating device, the same potential difference under all working conditions. This ideal is attained to-day in many installations within 1 per cent. The usual specification now requires that the manufacturers guarantee against a greater variation than 1 per cent. from the standard, thus allowing a range from permissible minimum to permissible maximum potential of 2 per cent. of the total.

Given a generator that will maintain constant potential at its terminals, the loss of potential due to the resistance of the conductors between the generator and translating device is the only factor to be taken into account. In practice this loss of potential—call it "transmission loss"—is a variable, the current changing with the work done in the system. Varying the conductor resistance to maintain equal transmission loss is not readily practicable, nor is it economical. Varying the potential difference at the generator is the usual method. As the potential difference must increase in accordance with the increased current output, a method of increase controlled by the current will be automatic. The generator being a dynamo, with its field not saturated, what method is more appropriate than a supplementary series winding of proper proportions? And the "over-compounded" dynamo is evolved, which is the dynamo *par excellence* of to-day.

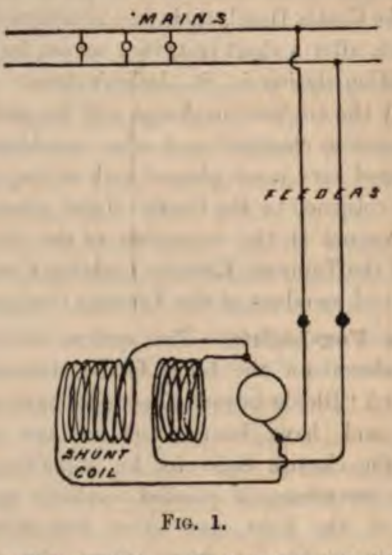


FIG. 1.

The calculation of the value of the supplementary winding has been discussed lately in the *Western Electrician*. It has been shown that there is a disturbing factor in the calculation—namely, the variation of the value of the original "constant potential" winding by the increased E.M.F. due to the supplementary winding. To illustrate: A dynamo is originally wound to maintain 110 volts at its terminals. It is then over-compounded, so as to give 110 to 115 volts in proportion to current output. But the value of the original winding, presumably a shunt coil, is enhanced by its receiving a terminal pressure greater than designed, and the supplementary or series winding cannot be calculated without allowing for the increased defect of the shunt.

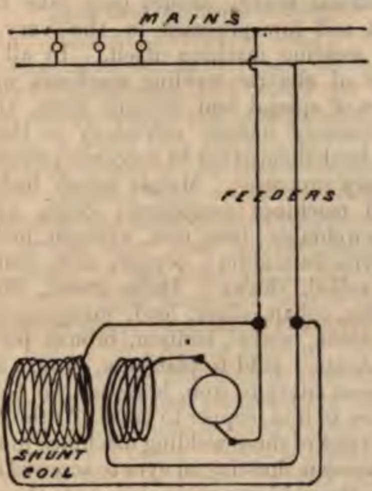


FIG. 2.

There are two methods of connecting the compound fields, familiarly called "short shunt," Fig. 1, in which the shunt coil parallels the armature only; and the "long shunt," Fig. 2, in which the shunt coil is connected to the terminals, and parallels the armature and series coil. I desire to point out another method of connection which eliminates the disturbing factor, illustrated in the preceding paragraph. The shunt winding may be connected "on the system," Fig. 3, that is, on the mains, or lamp leads or trolley wire and ground, which are to be kept at a constant potential difference. This method obviously will give the shunt winding a constant instead of a varying value, and the series winding can be calculated of full magnetic value to compensate for the transmission loss, a very simple matter

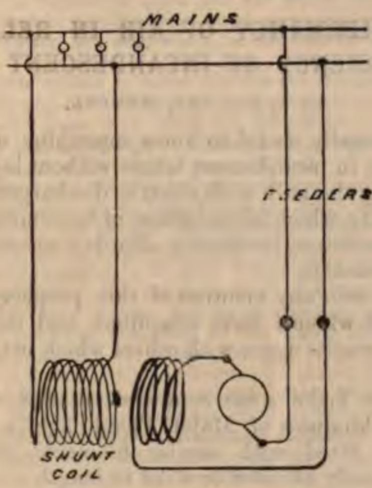


FIG. 3.

As to the practicability of this plan, it may be said that there are few constant potential plants in which the distributing mains do not return to the power station. Even where the mains need not for commercial reasons be led back, they are so returned as "pressure wires," or to light the station. No additional outside construction, therefore, is necessary. The shunt is simply disconnected from the dynamo or feeder bars, and connected to the mains.

This method of connection can often be applied with advantage to dynamos which have been already fitted with a series coil, and the value of the latter adjusted to a standard. Such dynamos are usually over-compounded 5, 10, or 15 per cent. These are convenient percentages, and no manufacturer can afford to furnish individual dynamos of other than standard winding.

With a compact building and the dynamo centrally located, the question that usually arises is not how to deliver the current at full pressure, but how to get the feeders small enough for the "drop" without heating. But with a plant that is a little too large, 5 per cent. is too little, 10 per cent. too much for economy, and so on. The man who has not longed for a dynamo "between sizes" has not been long in the business.

Take the shunt of a standard over-compounded dynamc off its terminals, and connect on the mains. You will find the machine is still over-compounded, but to a percentage about half what it was before. So the 5 per cent. will become 2½, and the 15 per cent., 7½. This suggestion is dedicated to the long-suffering expert who has had to run feeders upstairs and down again "to work off that 5 per cent.," in the hope that it will be a small mitigation of his ever numerous sorrows.—*Western Electrician.*

WELDING BY ELECTRICITY.

The ordinary meeting of the Institution of Civil Engineers was held on Tuesday, Sir John Coode, K.C.M.G., president, in the chair, when a paper was read on—

"THE APPLICATION OF ELECTRICITY TO WELDING, STAMPING, AND OTHER COGNATE PURPOSES."

BY SIR FREDERICK BRAMWELL, F.R.S., PAST PRESIDENT, INST.C.E.

Although large structures of wrought iron and of mild steel commonly had their parts united by bolting or by riveting, and although much ingenuity had been expended in so arranging and proportioning riveted joints as to obtain, in the joint, the greatest percentage of the strength of the material, nevertheless cases occurred in all structures where the union of these metals by welding became almost a necessity, or, if not a necessity, a matter of convenience and economy. Wrought iron, in addition to its many other merits, had the merit of being, *par excellence*, the weldable metal; mild steel also possessed this merit, but nevertheless there was always a feeling of doubt about a weld, although welds were of necessity largely trusted. No better illustration of this could be given than that of a common chain, each one of its manifold links having a separate weld. In the early days of making suspension bridges, the links, unless the wasteful process of cutting away a large portion of the bar was resorted to, were made by forming the eyes separate from the bar, and by welding them on. To obviate these difficulties, as long ago as 1845 Mr. Howard, of the firm of Howard and Ravenhill, of the King and Queen Iron Works, Rotherhithe, devised a plan which, while avoiding the necessity of welding on the eyes, avoided also the waste of material before alluded to. Within the last few years a plan of "upsetting" the ends of the bars by mechanical means, so as to obtain the requisite material for the formation of the eye, had been introduced in the United States. Although imperfection in a weld might arise from insufficient heat, or, indeed, from an excess of heat, or from the application of inadequate power to bring the heated surfaces together, probably by far the greater proportion of defective welds arose from the presence of some foreign body between the surfaces to be welded, or, as it was expressively called, "dirt" of some kind or another. Attempts had been made to obviate these difficulties by employing gaseous or liquid fuels, and, in rare cases, by the removal of the oxide of the metal from the surfaces by turning or planing. Allusion might be permitted to the welds that were successively employed for the welding of railway tyres in the days prior to the present system of making these tyres by continuous rolling and in the hoop form. These comprised an ordinary scarf weld, bird-mouth welds in both directions, single-wedge welds, and double-wedge welds. In all these cases hammering was employed, but for carriage tyres, at all events, the butt weld was used. In the early days of wrought-iron ordnance, where it was desirable to have in one piece a wrought-iron tube, so long in relation to its diameter that it would have been difficult to have welded it up as a single coil, it was made by welding two coils together, each of about half the length of the desired tube. It need hardly be said that every one of the modes of heating employed involved that the heat should proceed from the outside inwards. There were also the chances of inadequate heat, of an excess of heat, and, as had already been stated, of the presence of dirt in the weld. Moreover, there was the difficulty of ascertaining to what state the heat had attained. Commonly, in small welds the pieces were withdrawn from the fire, with the consequent risk of picking up "dirt" during reintroduction. Among the desiderata for heating for welding purposes, if the mode adopted should admit of uniform heating throughout the sectional area to be welded, it should admit of absolute regulation of the heat, it should be free from the possibility of introducing either particles of fuel or gases between the welding surfaces, and it should admit also of complete inspection during the time the heating was going on. All these desiderata were afforded by electrical heating. As regarded the power of an electric current in passing through substances to develop heat, the most familiar instance was probably that of the carbon filament of an incandescent lamp, now so largely used in theatres, in clubs, and in private houses. It was common knowledge that electrical energy was compounded of E.M.F. or potential, or preferentially, pressure, multiplied into the amount of the current, or the pressure multiplied into the quantity. Whenever this electrical energy had to pass through a conductor, the resistance of that conductor to its passage destroyed a certain portion of the electrical energy, which energy so destroyed reappeared in the form of heat, and must appear in the very conductor which had been the cause of the destruction of the electrical energy. Therefore, the amount of heat produced must be that which was the thermal equivalent of the electrical energy destroyed. What the temperature would be—and in most cases it was the temperature reached by the conductor, as the result of the passage of a given quantity of current, which was of importance—depended not only upon the heat-units produced, but upon other considerations. Although electric energy was represented by the multiplication of the pressure into the current, it would be found that the heating effect of any given current was independent of the pressure, and that the heat produced was in proportion to the current employed. As regarded the heating effect of any given current upon different materials, if there were an absolutely perfect conductor, which offered no resistance to the passage of an electric current, no amount of electrical energy could heat it, because no extent of conductor could destroy any part of that electrical energy. On the other hand, in the case of a material absolutely impermeable to an electric current, it need hardly be said that no heating could result, as no current could pass. Fortunately, the materials commonly welded, iron and steel, held a very happy position as conductors in the scale of metals for the purposes of being electrically heated. The electrical resistance of metals increased, however, with an increase in their temperature. This question of the increase of resistance due to increase of temperature had been investigated by Dr. Hopkinson, and the results obtained had been published in the *Philosophical Transactions* for the year 1889. This increase of resistance to the passage of the current, as the temperature increased, was of great utility in electrical welding. Consider the two ends of bars to be welded, mere ordinary rough surfaces, the first contact was made upon numerous points, through these the current passed, and they became rapidly heated, and offered more resistance. As endway pressure was applied the surfaces in contact became of larger and larger area, until all were heated up uniformly. The greater current sought those parts which, although in contact, were at a lower temperature, and this went on until contact and uniform temperature were obtained. Having regard to the fact that the particular form of electrical energy needed for imparting heat was that of large current and low pressure, it would be seen that there was very great difficulty, amounting almost to a commercial impossibility, of transmitting electrical energy in such a form over any but very short distances, for unless the conductors were of enormous size they themselves would be injuriously heated by the passage of the current, and, moreover, the pressure required to drive these large currents through any considerable length of conductor would be so large a percentage of the working pressure as to add very greatly to the power required. For these reasons it was desirable that the electrical energy should only take the form of large current and low pressure in the very neighbourhood of the welding machine itself. In all probability the great use of electric welding machines would be for uniting pieces of special and difficult form, and for dealing with refractory metals, refractory in the sense that they did not lend themselves to successful welding by any of the ordinary processes. Metals which had been dealt with in such machines comprised: Steel, every variety seemed to be weldable; iron, cast, wrought, malleable, case-hardened, ferro-aluminium; copper, cast, rolled, drawn; brass, cast, rolled, drawn; Delta metal, Muntz metal, aluminium, tin, cobalt, silver, lead, manganese, gold, zinc, bismuth, platinum, nickel, iridium, bronze, phosphor, silicon, gunmetal, etc.; gold to platinum, bronze to iron, iron to steel, German silver to iron, brass to iron, German silver to brass, copper to iron, copper to brass. At the Crewe works Mr. Webb had one of these welding machines in use. He had it at work at present shutting on eyes to screwed rods of some $\frac{7}{8}$in. diameter: the weld was made close up to the screw, which was in no way injured in the process. It has also been employed to weld ends to tubes, to weld together the parts of twist drills which had been broken, and to weld best steel for tools on to commoner materials. It was obvious that a machine that gave the power of heating any material with an absolutely controllable heat, and that enabled that heat to be inspected and to be communicated without the advent of impurities, must have many uses in the arts, in preparing pieces for brazing, for stamping, and in a variety of other ways; in fact, there could be no doubt that the existence of such a machine would itself give rise to a large number of new uses.

THE DIATHERMANCY OF AIR IN RELATION TO THE EFFICIENCY OF INCANDESCENT LAMPS.*

BY F. HIGGINS, MEMBER.

It is occasionally useful to know something of the state of the vacuum in incandescent lamps without injuring them by perforating the bulb with electric discharges.

The property which air possesses of transmitting radiant heat in proportion to its density, affords a means for obtaining this information.

I have not seen any mention of this property in works on the subject which I have consulted, and do not know whether my results agree with others which may have been obtained.

In order to make some comparative tests, I obtained, through the kindness of Major Flood-Page, a number of lamp bulbs, fitted with similar filaments of platinum iridium, as nearly as possible alike in length.

Some of these bulbs were exhausted to the highest possible degree, some left open to the air, and others exhausted to a pressure equal to $\frac{1}{10}$th inch of mercury.

With a sensitive thermoscope the different qualifications of the three descriptions can be made apparent.

The lamps of each class being very similar in their behaviour, it is only necessary to give the results obtained with one of each type.

The highest possible exhaustion is that which is supposed to be the condition of the electric lighting bulbs; the $\frac{1}{10}$th inch gives a vacuum like that necessary for the Geissler tubes; the air bulb, as before mentioned, open to the air.

By means of adjustable resistances and batteries the three lamps were brought to the same degree of red heat, as nearly as could be judged.

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* Paper read at the Institution of Electrical Engineers, April 10.

The potential at the filament terminals and the volume of current flowing were measured in each case, with the result that the air bulb required, to produce the red heat, 7·02 watts; the $\frac{1}{10}$th inch vacuum, 5·336 watts; and the highest possible 0·646 watts only.

With the same lamps in series the highest possible becomes white hot with a current which scarcely causes visible redness in the air bulb filament, and only dull redness in the $\frac{1}{10}$th inch vacuum.

The relative conductibility of the three bulbs, as measured by radiation upon a sensitive thermoscope, was—

Air, 325deg.
$\frac{1}{10}$th inch vacuum, 250deg.
Highest possible, 35deg.

When the same filaments were raised to incandescence, that in the air bulb required 31·2 watts per candle; the $\frac{1}{10}$th vacuum, 15·20 watts per candle, and the highest possible vacuum, 4 watts only per candle.

These results show that of two similar lamps one, merely from imperfect vacuum, may require double the current that is necessary in the other to produce the same amount of light, and at the same time become dangerously hot. The two extremes of my scale show, for example, the absorption of nearly eight times the force in the case of the air bulb that is necessary to produce the same effect in the most efficient lamp with a higher vacuum.

It is possible that vacua produced by chemical absorption of carbonic gas may be more perfect even than this, and advantageous to use. There is always some air left in a vacuum produced by a pump; but it is possible to imagine that no gas will be left unabsorbed in the case of caustic potash and carbonic acid gas being employed.

Lamps which differ much in the state of their surrounding medium differ also in their behaviour when current is applied. Those which have a very perfect vacuum attain incandescence slowly, and lose it in the same way; while those which are imperfect start suddenly into incandescence, and as suddenly lose it.

DISCUSSION.

General Webber asked Mr. Higgins if he proposed any means of testing the degree of exhaustion without using the methods ordinarily employed by lampmakers.

Major Cardew enquired whether he had repeated his experiments with lamps having carbon filaments.

Mr. G. S. Ramm asked if his apparatus would indicate the difference between a vacuum of $\frac{1}{10}$in. and the most perfect obtainable. In his (Mr. Ramm's) opinion there was a great need of something to replace the ordinary coil test, which in the case of carbon lamps is unreliable.

Mr. Granville wished to know whether the thickness of the bulb made any difference in the efficiency, for he thought the heat-conducting power of the glass must affect the temperature of the filament. He also asked if it would not be advisable to use double bulbs, so as to have the benefit of the diathermancy of both.

The **President** said the well-known method of testing the state of the vacuum by feeling at the bulb whilst the lamp was alight was a fairly good guide. He thought the differences observed by the author were not due to diathermancy, but rather to convection and diffusion.

Mr. Higgins, replying to General Webber, said his apparatus had been used practically. In one case he received a lamp which was supposed to be exhausted to $\frac{1}{10}$in., but his thermoscope indicated a lower vacuum. On returning the lamp to the maker his prediction was verified. His apparatus was so sensitive that it gave a deflection of 600 divisions if touched with the finger. In answer to Major Cardew he said he had found the radiation from filaments of different materials to be alike. Referring to Mr. Granville's question, he said he had not tried the effect of different thicknesses of glass, but he believed it better to use large bulbs rather than small ones. As to the cause of the phenomena observed, he once suspected that convection was operative, but after investigating the matter had concluded that it had no effect.

CORRESPONDENCE.

A PLEA FOR THE ENGINEER.

TO THE EDITOR OF THE ELECTRICAL ENGINEER.

SIR,—Being a profound believer in the future of applied electricity, I watch with interest the progress of the work of this kind, and the efforts made by our learned professors in the technical education of the rising generation of electrical engineers.

I therefore claim to be able to speak without prejudice upon the subject which Mr. Sydney F. Walker enlarged upon in your last issue.

My object in entering the lists against so eminent an authority is to counteract the mischief which I believe such remarks as his is calculated to have upon the education of the young man who desires to become a successful and practical worker in the widening field of electrical engineering.

Mr. Walker has not put the case at all fairly by the suggestion that a smattering of electricity is considered by mechanical engineers to be all that is necessary for practical purposes, and, moreover, he is not in accord with the experience of engineers who have become specialists in other branches of the profession. What would be said of a mechanical engineer with a smattering of knowledge of cotton machinery who opens works for the manufacture of this class of work, or, worse still, as consulting engineer for cotton manufacturers and calico printers?

What is to be said of the electrician having had three years in the works of a dynamo manufacturer who presumes to advise upon triple expansion engines, electric traction, and the construction of permanent way? And yet there are engineers, as Mr. Walker must know, who are capable of undertaking the latter, and whose knowledge of electricity, though recent, could not rightly be called a "smattering."

To every illustration of an electrical blunder by a colliery manager, there could be given many instances of engineering blunders by electricians who have miscalled themselves electrical engineers.

I would ask those entering into the profession to carefully study the past history of the leading and successful men of that ilk in this country, and they will not doubt the advantage of a training that embraces general engineering first, and special branches later.

The fact is, that the great demand which has sprung up has induced half-fledged electricians to rush into electrical engineering because at present they find it profitable, and will do so while the public are content to pay the piper. My contention is that with a good foundation in mechanical engineering the acquirement of the requisite thorough knowledge of electricity presents no more difficulties, and perhaps less, than locomotive work, machine tool work, pumping, sewage, or mining work.

Mr. Walker's assertion in reference to expert witnesses would support my own view, if it were not well known to those unfortunate people who have suffered lawsuits of this nature, that experience in the witness-box and a subtle tact are of more value than sound knowledge of the subject involved. These very experts, however, will be found in most cases to have been engineers before they were electricians.

The manufacture of the secondary battery is no more part of the work of the electrical engineer than the manufacture of pulleys or gland packing is essentially the province of the mechanical engineer, and, therefore, need not be discussed as such, or it would be necessary to class watchmakers as mechanical engineers, and butchers as surgeons. The necessity of a mathematical knowledge is claimed for electrical work. Surely there is a much wider knowledge of mathematics required in the very consideration of steam action in a cylinder alone.

But with the exception of Watt, Rankine, and Carnot, the world at large have received untold benefits from the wonderful practical ability, mostly of comparatively uneducated engineers, to whom all praise be given.

Mr. Walker is, methinks, anticipating a high development of subdivision of labour when he talks of calling in the services of mathematicians, chemists, mechanical and other engineers, and of surgeons, to assist him in his labours.

I have never had the misfortune to make any of the grotesque and expensive blunders through "dabbling" in electrical work which Mr. Walker rightly laughs at, but, taking the remark as coming from the profession he exalts, I should conceive it a particularly dangerous game of stone-throwing.

In conclusion, I would paraphrase the above writer's remark, and say "Let us be practical engineers first, and what you please after."—Yours JAMES ARMER.

10 and 11, Que

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CHELMSFORD.

"I feel it a great honour," said the Mayor of Chelmsford on Monday night, "to be in the proud position to inaugurate the electric lighting of this town—the first in this kingdom, and I believe the first in the world, to have its public thoroughfares wholly lighted by electricity." We are not quite sure that these were the exact words used on the occasion, but they give the purport of those used, and the occasion was one to be proud of. Chelmsford has acted while others talked. The town has shown its faith in its townsman and in the system of lighting he has had so great a share in developing. But in the first place it will be best to describe the occasion. The Corporation of Chelmsford some time ago entered into a contract with Messrs. Crompton and Co. to install the electric light in the streets of the borough. On Monday evening the work was supposed to be complete, and the time of the contract commenced. The Mayor and many members of the Corporation, together with ladies and gentlemen interested in the work, were invited to witness the ceremony of turning on the current. This work was excellently performed by the Mayoress (Miss Brown) and the Ex-Mayoress (Mrs. Chancellor), the switch for the arc lighting being turned on by the one, and the switch for the incandescent lighting by the other. Subsequently, the usual custom was observed, and Corporation and guests made merry at a banquet to celebrate the auspicious occasion. It is needless to state that the after-dinner speeches were numerous, and if the oratory was not that of parliamentarians, it had the advantage of being the honest and outspoken expression of the opinions really held by those who acted their part in the performance.

The difference between Chelmsford and the towns that have been earlier in the field is that the former has discarded gas altogether for public lighting, while the latter have generally introduced electricity as an experiment over a comparatively small area. There is nothing to fall back upon at Chelmsford. It is the electric light or darkness. Of course the Corporation has the enormous advantage that the works of Messrs. Crompton and Co. are at Chelmsford, that the central station is in the works, and if any hitch arises, there must be the feeling of satisfaction that every appliance that knowledge, ingenuity, or skill can bring to bear upon overcoming the difficulty will be utilised at once. There is no sending for the physician. He is on the spot, and, further, cannot, because of his reputation, permit even a hint of uncertainty to exist. We congratulate Chelmsford upon the bold step taken of depending entirely upon the electric light as the illuminant of the public streets. The action taken will be watched with great keenness by other local authorities.

Mr. Crompton, in his after-dinner speech, referred to several topics of a much wider interest even than the public lighting of streets, but we cannot at present enter into the domain of the possibilities arising from the general transmission of power electrically. Our readers know that our sympathies are in this direction—we were almost alone in our advocacy of such transmission in earlier days. We were told by eminent members of the profession that such advocacy was out of place, that its time was not yet, but convert after convert has been added to those whose hopes lie in this direction from the Prime Minister downwards. As Mr. Crompton said, the greatest rubbish is written and spoken about electrical matters; it seems, indeed, that electricity is the happy hunting ground of those who pose as claiming the title scientific, and anything said seems to be accepted by the multitude as without a doubt true. Great as is the flight of fancy of the human mind, the possibilities which arise and the changes in all directions that may occur when electrical transmission of power is general, can hardly be conceived. But the present is with light, not power. Mr. Crompton stated that the system adopted at Chelmsford, partly arc lighting and partly incandescent, had been adopted after careful consideration as that most suitable for towns of a similar size and character to that of Chelmsford. The arc lighting is restricted to the main streets, the streets mostly occupied by shops, and in which most of the business of the town is transacted. The other streets are lighted by incandescent lamps. The wires are practically all overhead, carried on poles. The direct current is used for the arc lamps, and the alternate current for the incandescent. The latter has a pressure of 2,000 volts, transformed down at the points of usage to 100 volts. The wires are insulated, and so placed as to be out of harm's way. No doubt there are not the same objections against overhead wires at Chelmsford as there would be in London, or Manchester, or any large manufacturing towns.

The one question to which most local authorities will turn is to that of cost. It is almost a pity that the charges made cannot be kept secret. We say this remembering perhaps that in this we have in another capacity done more than anyone to make such a secret impossible. For nearly twelve years, the information relating to by far the larger number of public tenders throughout the length and breadth of Great Britain and Ireland have passed in some way or other through our hands, and we have insisted that nothing in regard to such tenders should be hidden. There are cases, however, in which the price at which certain work is done gives an erroneous impression. One of the first principles of business is to get a profit. Now, neither Messrs. Crompton, nor any other supply company, can hope to get a profit from public lighting only. The public lighting, whether by gas or by electricity, is on a different footing and has always been treated differently to private lighting. The public lighting is the sop thrown in by companies to do away with local opposition. In order to obtain a just return for expenditure incurred, the public lighting must be supplemented by a good deal of private lighting. The more of this kind of lighting there is the better for the consumers individually, and the better for the supplier. The latter can supply at a cheaper rate per unit, by which the former benefits.

The aim, then, of the supply company is to get the patronage of the local authorities, and when arranging for the public supply to arrange also for private lighting. When the mains are really in the streets, there is no difficulty of connecting houses bordering such streets, but till the mains are there, it is a little too speculative to lay them in order to supply one or two houses, it may be, a mile or so away from the central station. The public lighting, then, provides the nucleus around which it becomes easy and simple to make extensions. Messrs. Crompton and Co., as well as the Corporation of Chelmsford, are to be congratulated upon their enterprise, and we trust the private lighting arising from this installation will be as extensive as the public lighting—that is, will include the whole borough.

PRESSURE v. POTENTIAL.

Bravo, Sir Frederick. When the solo singers take up a refrain, it is sure to become popular. The thousand and one members of the chorus may long have felt the beauty and appropriateness of the refrain, but still their collective wisdom gives not the stamp of authority. When, however, those upon whose shoulders honours have thickly fallen begin to use expressions, and "preferably use them," the rank and file hail with delight innovations that bring terms and phrases more within the compass of their understanding. We often feel, and we say so, that scholasticism is apt to continue the differential process to such an enormous extent, that it takes three parts of a lifetime to learn the minute distinctions which, with high sounding words, are made to seem of astounding proportion and importance. It has been said in the history of nations, that the time and the want always produce the man. What a blessing it would be if in the electrical profession a man could be found with the genius and bluntness of Carlyle, to bring home to those who sin so greatly the fault of the age. The ninety-and-nine are crying for simplification. They want to be told elementary truths in homely language, but usually they are given some pabulum of a totally different nature to that they crave for. The ninety-and-nine have a glimmer of what pressure or difference of pressure means, but it looks so much more learned to use "potential," which b [illegible] ls, The mountain will move if you apply pressure enough. Let it move in the direction of playing to the gallery.

LITERATURE.

Electrical Engineering for Electric Light Artisans and Students. By W. Slingo and A. Brooker. With 307 illustrations. Longmans, Green, and Co. London, 1890.

Three books of more than usual importance have been issued within the last week or two, that on "Electrical Engineering," by Messrs. Slingo and Brooker, the second edition of "Electric Transmission of Energy," by Mr. G. Kapp, and one on "Influence Machines," by Mr. Gray. Each of these books deserves special consideration, and we shall refer to them in the order in which we have received them, restricting our present remarks to the book whose title is given above. So far as we can recollect at the moment, the new era of electrical literature was introduced in the little book by the late Prof. Fleeming Jenkin, published by Messrs. Longmans. Subsequently the late Prof. Clarke Maxwell and Sir William Thomson issued their splendid works dealing more especially with the higher branches of the subject, but for many years the only books that were really suited to students, or, at least, to students who desire to know the way the world is moving, were those of Prof. Jenkin before mentioned, and of Mr. Cumming, of Rugby. Several excellent books, indeed, were devoted to special subjects such as telegraphy, and especially to testing. So far as the latter subject is concerned, the work of Mr. H. R. Kempe is far and away superior to any other that has ever been issued. Till quite recently, however, the majority of what may be termed school books and students' books have proceeded very much on the old-fashioned lines. Messrs. Longmans, in their issue of the work of Prof. Fleeming Jenkin, commenced the period of awakening, and these publishers have gone still further in issuing the book by Messrs. Slingo and Brooker, entitled "Electrical Engineering." The authors of this book show that they appreciate the changed conditions due to the study of electric currents as required in electric lighting and electric transmission of power. The old-fashioned drawing-room experiments, leading to no practical object, undertaken by lecturers and schoolmasters because they were pretty, have given place to a vast amount of practical information that shows that the authors have delved deeply into the current literature on the subject. A very large part of the book is devoted to descriptions of the various apparatus which has become prominent in practical work of late years, and it is evident that throughout the aim has been to supply information which may be put to a practical use. It may be that a hypercritical examination would suggest the elimination of a good deal of the descriptive matter, but it is extremely difficult at the present stage of matters to generalise too largely. In future days probably text-books such as this will not attempt to describe very large numbers of dynamos, but will generalise on the whole subject.

Ten years ago it was customary to point out that our information was so meagre that it was almost impossible to write a specification to which a dynamo should be constructed. That time of ignorance is now past, and not only are such specifications written, but they are actually becoming as common as specifications for a portable engine. Thanks to the workers whose labours are more or less briefly described in this book, almost every point in the construction of dynamos has been considered. We do not mean to say that there is no further room for improvements; what we mean is that, broadly speaking, the dynamo is an exceptionally efficient machine, and improvements will lead only to a greater fractional efficiency, and not to any great advance. Our purpose will be best served by detailing somewhat the method followed by the authors in the production of this book. They commence by calling attention to the phenomena of current, potential, and resistance, then the practical units which have been adopted for measurement as well as the absolute system of units from which the practical have been derived. The apparatus used in measurement, such as resistance-boxes, galvanometers, ammeters, voltmeters, etc., are described, with a short account of batteries usually required for obtaining current for testing purposes. Then we have considered the general laws of magnetism, and the interaction of magnetism and currents concluding the first portion of the book, consisting of some 230 pages. The latter portion deals with dynamos, their fundamental and mathematical principles, followed by a description of a large number of machines by different makers. The whole work is exceedingly well illustrated, and in many cases sectional drawings are given illustrating the machines described. There is no doubt that the authors will be led in a new edition to considerably revise some portions of the book. Prof. Silvanus Thompson's Cantor lectures, when published, will give a large amount of information concerning electromagnets, which has hitherto been lost by being found only piecemeal in various scientific publications, besides much that has been done by Prof. Thompson himself. After the consideration of dynamos, motors, and transformers, the authors devote a chapter to secondary batteries, and this is followed by others on arc and incandescent lamps. The work concludes with a general review of installation equipment, fittings, etc. It will be seen that the ground travelled over is very large. To adequately discuss the matter of the book would take far more space than we can at present devote to it. There is much to which we might demur, but on the whole we must decidedly commend the work as of that character and containing that kind of information which it is most desirable the young electrical engineer should study.

LAMPHOLDERS.

Messrs. John Davis and Son, of All Saints' Works, Derby, are introducing a variety of new lampholders. It may be that the holders do not possess that elegance of form which appeals to the æsthetic, but they are intended for use upon workmen's benches or in positions where a change in the position of the light is frequently necessary. Fig. 1 shows a table or bench standard, the base of which is heavily weighted to make the standard stable, and adjustments are provided so that the lamp can be raised or lowered, or set to any angle. Fig. 2 also shows a table or bench standard, the base of which may be screwed down, while Fig. 3 shows a bracket-holder, with enamelled reflector to hold large incan-

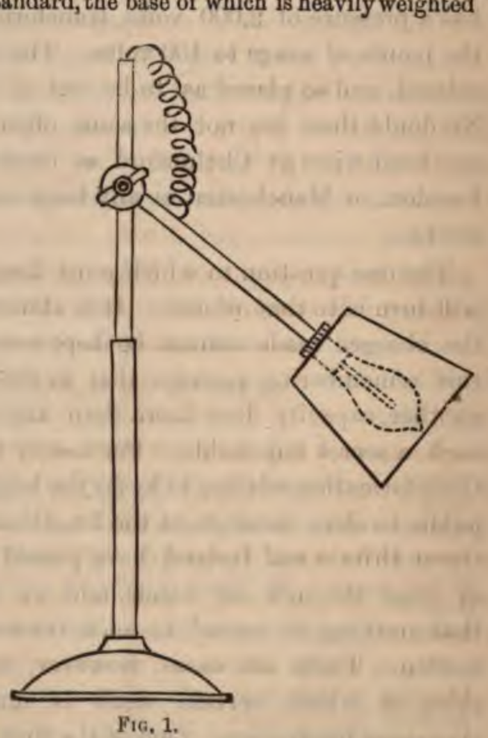


Fig. 1.

descent lamps from 100 to 600 c.p. These new patterns are made in wrought or cast iron, or in lacquered brass.

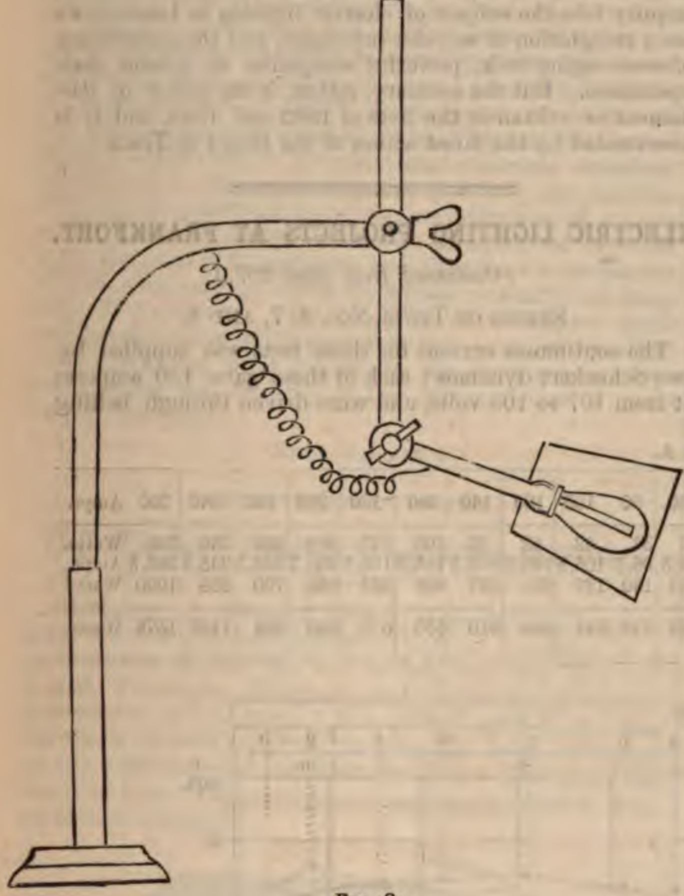


FIG. 2.

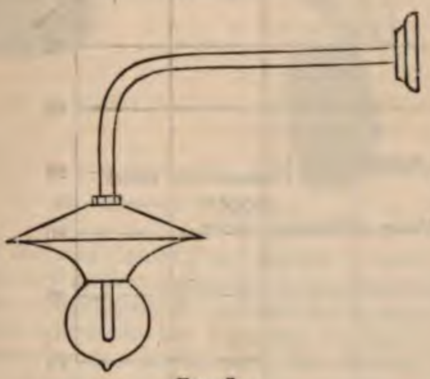


FIG. 3.

Further description is unnecessary, as the standards are so simple the illustrations fully explain them.

TRANSFER OF ORDERS.

It may be within the recollection of our readers that we referred to this subject in our issue of March 28. Last Saturday the *Times* had an article and a leader upon the subject. The gist of the article was favourable to the action of the Board of Trade as desired by the municipal authorities, and the weight of the *Times'* influence is in that direction, as will be seen from its leader, which we give below:

"In an article entitled 'Local Authorities and Electrical Lighting,' which we publish to-day, a well-informed correspondent communicates some facts of supreme importance, not merely to local authorities, but to investors and the public in general. What may prove to be a distinct step in the promotion of electrical lighting has just been taken. Ever since Parliament passed the Electric Lighting Act, 1882, we have heard complaints of the obstacles placed in the path of enterprise. One of these is to be removed. When that measure was passed we had before us the mistake committed by Parliament in earlier days in permitting, as to gas and water, the growth of monopolies which could not be bought up except at enormous prices. The failure to deal by Lord Cross's Bill with the colossal claims of the London Water Companies was in the recollection of all. So desirous was Parliament to avoid repeating this mistake that it fell into another. It excluded monopolists; unluckily, the statute which was to 'facilitate' the supply also stifled commercial enterprise. Parliamentary restrictions, in concurrence with other causes, virtually put a stop to the development of electrical lighting. The scheme of the original Act was that supply should be carried on under a system of licenses or provisional orders of the Board of Trade; that local authorities might at any time after the expiration of 21 years buy out the private undertakers upon giving six months' notice, and that powers or liabilities should not be transferable. In several respects this did not answer. The period for which the license was granted proved too short, and the Act of 1888 extended it from 21 to 42 years. The restriction upon transfer of powers remained and seriously discouraged applications, especially by local authorities. They might desire to keep control over electric lighting within their areas and yet hesitate to sink the capital requisite as undertakers and commit themselves to the task of supplying electricity for a long period. It would have suited them better to acquire authority under the Act, and to farm out for a long or short period their powers on the best conditions which they could get. Unfortunately, the terms of section 11 of the Act of 1882 were opposed to such arrangements. It is most probable that the intention of those who altered in the House of Lords that section was to facilitate them; as not infrequently happens in our legislation, the alterations introduced had, on the whole, an effect contrary to that designed. The model form of provisional order hitherto sanctioned by the Board of Trade did not permit of such assignments. Now, however, yielding to pressure from several quarters, it has agreed to the insertion in provisional orders obtained by municipal corporations of permission to transfer their powers and liabilities. From this we may expect to see important results. Hitherto, as figures show, there has been hesitation on the part of municipal corporations. No less a sum than nine millions sterling is proposed to be raised under the various schemes of electric lighting promoted this session. Only two millions of that sum are assignable to the schemes of municipal bodies. Next session the proportion may be very different. The reason for hesitation is in many cases almost gone when it is known that a local authority may divest itself of its statutory duties and liabilities, and lease its powers to a company willing to rent them.

"Another change is in progress. Manifestly, in very many instances, the period of 21 years, for which the original Act proposed to grant powers, was too short. But the confidence in the future of electricity grows; companies are more enterprising than they were in 1882; and it is apparent, from what is happening in more than one town, that the period of 42 years substituted by the Act of 1888 may be, in the point of the investor, unnecessarily long. The Board of Trade may grant a provisional order to anyone, notwithstanding the refusal of the local authority. But, as a rule, the consent of the local authority is a condition precedent to private undertakers obtaining necessary powers; and this consent is sometimes sold on special terms. In several towns to which our correspondent refers the local authorities have granted their consent only upon promoters waiving their rights as to 42 years, and agreeing to sell their undertaking on terms much less favourable to them than those stated in the Act of Parliament. What is the precise purport of the latter is not very clear. Borrowing the uncouth, dubious phraseology used in the corresponding section of the Tramways Act, 1870, Parliament said that the undertakers of electrical enterprises should receive upon sale 'the then value of all lands, buildings, works, materials, and plant of such undertakers suitable to and used by them for the purposes of their undertaking,' provided that 'the value of [illegible] works, materials, and plant shall [illegible] value at the time of the purchase, due regard being had to the nature and then condition of such buildings, works, materials, and plant, and to the state of repairs thereof, and the circumstance that they are in such a condition to be ready for immediate working, and to the suitability of the same for the purposes of the undertaking.' Out of this mass of verbose confusion the investor anxious to know what is in store for him can extract no certain comfort. He wishes to be assured that in case of purchase the undertaking will be valued as a whole, and that the dynamos, batteries, wires, insulators, etc., will be appraised not as so much isolated machinery, but as integral parts of a large profitable concern. He cannot, however, be confident how the courts would direct an arbitrator to proceed. In regard to the similar words in the Tramways Act, 1870, counsel of eminence whose opinions have been taken are not agreed, while all think that materials are not to be valued at their mere breaking-up prices, there is no consensus as to whether the arbitrator may fully take into account, in all its significance, the fact that they form part of a large going concern.

"The general purpose of our correspondent's observations is noteworthy—they all point to an increase, sooner or later, of the operations of municipalities. Little less than one-half of the vast capital invested in gas belongs to municipal corporations; and the tendency of legislation is to enable them to control both tramways and the supply of electricity. Local authorities are not at liberty, except under special Acts, to work the former. But they may purchase them; they may lease them for any period not exceeding 21 years; and this is likely to present itself as an expedient course to not a few public bodies. They may do much the same as to the supply of electricity. Whether all this is a desirable result—whether it is advantageous that the functions of public bodies should be greatly increased, and that they should more and more interfere with commercial or *quasi*-commercial affairs and be engaged in settling the terms of the leases of profitable concerns — is open to grave question. Obvious abuses are possible, nay, probable, and perhaps the public would be better off, electric lighting more developed than it is to-day in England, if there had been less jealousy of private undertakers and less favouritism towards municipalities. In Major Marindin's report, founded on his exhaustive official enquiry into the subject of electric lighting in London, we see a recognition of sounder principles, and the expediency of encouraging rich, powerful companies to extend their operations. But the contrary, rather, is the policy of Parliament as written in the Acts of 1882 and 1888, and it is accentuated by the latest action of the Board of Trade."

ELECTRIC LIGHTING PROJECTS AT FRANKFORT.

(Continued from page 297.)

SERIES OF TESTS NOS. 6, 7, AND 8.

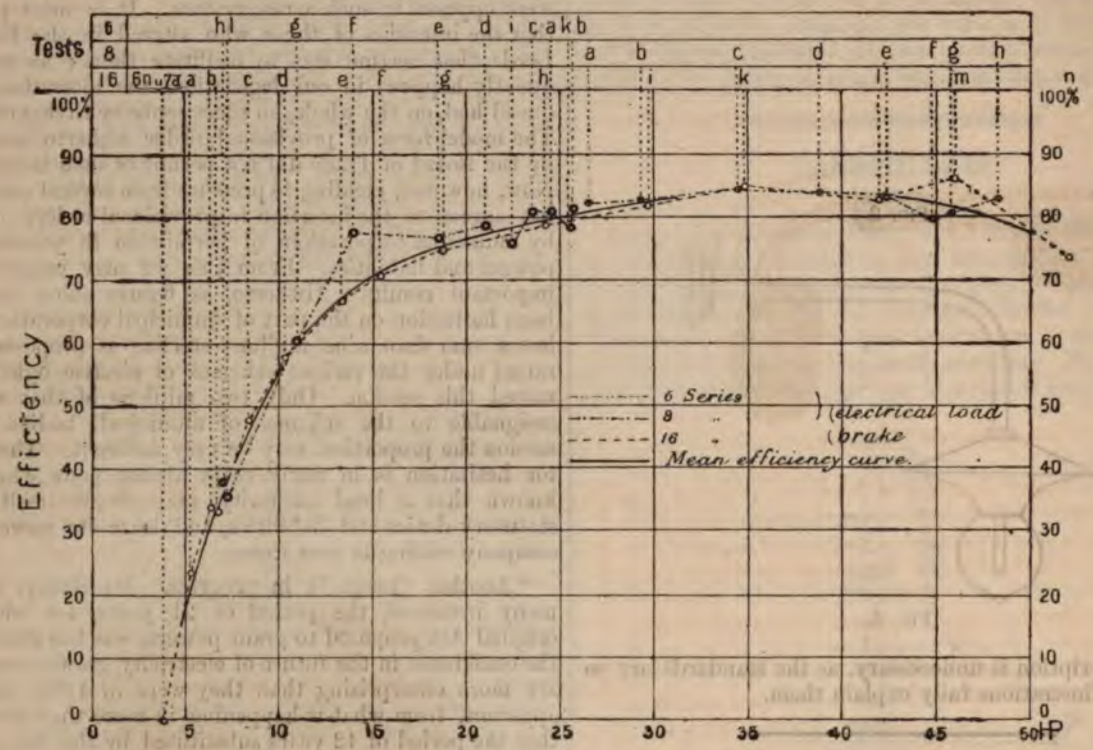
The continuous current for these tests was supplied by two Schuckert dynamos; each of these gave 150 amperes at from 107 to 108 volts, and were driven through belting by a 30 h.p. vertical Daevel engine running at 250 revolutions. The pressure at the terminals of the dynamos was as far as possible kept constant at from 107 to 108 volts. A shunt dynamo was used as motor, and, as the winding was not exactly the resistance required, a resistance was inserted for the purposes of these tests, the loss through which is allowed for in the tables. The energy put into the motor was measured by a Hummel ampere and volt meter, and the revolutions by a Buss-Sombart tachometer. The motor was used to drive a third machine. The efficiency of the third machine was stated by Mr. Hummel to be from 87 to 88 per cent., and these figures were adopted in the calculations. The calculations relating to the Schuckert motor were based on the following resistances:

(*a*) Resistance of the armature .... = 0·0155 ohms.
(*b*) Resistance of the main circuit winding = 0·00423 „
(*c*) Resistance of the shunt winding ...... = 19·97 „

From this resulted Table A, for the loss in the main circuit and in the armature.

TABLE A.

Useful current	20	30	40	50	60	70	80	90	100	120	140	160	180	200	220	240	260	Amps.
Loss in main circuit	2	4	7	11	16	21	27	34	42	62	83	108	137	169	205	244	286	Watts.
Current in armature.....	25,3	35,3	45,3	53,3	65.3	75,3	85,3	95,3	105.3	125,3	145,3	165,3	185,3	205,3	225,3	245,3	265,3	Amps.
Loss in armature	10	19	32	48	66	88	112	140	172	244	327	422	533	656	790	936	1090	Watts.
Total loss in armature and main circuit together	12	23	39	59	82	109	139	174	214	306	410	530	670	825	995	1180	1376	Watts.

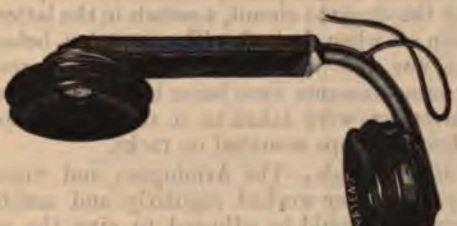


It will be unnecessary to set out at full length the tabular arrangement of the various tests, but it will be sufficient to give the general results. Take the test No. 6A. The mean of five runs gave as the energy to be used 18,435 watts. Of these 385 watts were lost in the extra resistance required, so that the available energy to put into the motor was 18,050 watts, or about 24½ h.p. Of these, however, the losses in the main circuit, shunt circuit, in friction of bearings and air reached 2,136 watts. The energy recovered being 12,497 watts. The electrical efficiency, therefore, would be that out of the 24½ h.p. put into the machine 19·8 h.p. are accounted for, giving an efficiency of 81 per cent. The next series showed an efficiency of 81·5 per cent., the next of 81 per cent., and then were a long series of tests with varying loads, the efficiency at its worst being only 35·5 per cent. The efficiency at the higher loads reached as a mean of 32 tests 82·7 per cent., but perhaps what will appeal more directly to our readers is a curve representing the efficiency of this motor, which is given on previous page.

(To be continued.)

THE MIX AND GENEST TELEPHONE COMPANY.

Of the manufacturers of electric apparatus in Germany, there are few that have achieved such an extension in a short time as Messrs. Mix and Genest, now the Mix and Genest Telephone, Telegraph, and Lightning Conductor Manufacturing Company. It is not too much to say that the whole German telephone business has been influenced by the inventions and manufactures of this firm, since the Imperial Postal Department has exclusively adopted their pattern of telephone.



Mix and Genest Telephone.

The firm of Mix and Genest was founded in 1879, and has risen from very modest beginnings in less than 10 years to be one of the largest electrical concerns in Germany. At first only house telegraphs, and lightning conductors, and similar apparatus were manufactured, but the firm soon succeeded in achieving a good business reputation, and as it was at this period that the telephone first began to be talked about, the firm immediately recognised the vast importance the industry was to become, and at once set about laying themselves out for manufacture by enlarging their premises and perfecting their plant. The factory was transferred to extensive premises in a favourable quarter of Berlin, and was fitted out with machinery of the most modern and approved construction. With the enlarged scope of its productions the firm began to be known widely, not alone in Germany, but in other parts of the world. At that time the Mix and Genest microphone was brought out, and this invention, together with the care bestowed on other departments of a rapidly increasing telephone connection, made them one of the leading firms in the telephone industry in Germany. The whole telephonic service of the German Empire underwent, after this invention, a thorough technical reorganisation, and the Imperial Postal Department, as we have said, exclusively adopted the Mix and Genest telephone for the telephonic service throughout Germany—a decision in itself sufficient to convert the Mix and Genest factory into one in the first ranks of electrotechnical industry.

Their works are situated in the Neuenburgerstrasse, Berlin, and contain in the front and lateral buildings the commercial and technical offices and the showrooms, while the six-storeyed building at the back contains the engine-house, the smithy, the warehouse, the workshops, the testing-rooms, the electro-plating department, the joiners' and mechanicians' workshops, the packing-rooms and other departments. All the six floors are connected by means of lifts, and everywhere the newest contrivances for the protection of workmen against accidents have been applied.

The factory is fitted out with the best machinery for the wholesale manufacture on the largest scale of all telephone apparatus, an arrangement which enabled them to furnish microphones to the German Imperial Postal Department within a limited period in the extremely large quantities rendered necessary by its decision.

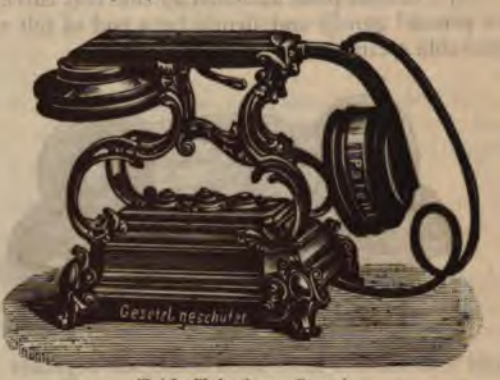


Table Telephone Stand.

Telegraph and electric apparatus for ordinary use have at the same time received great attention, and large amounts are turned out, but it is especially in the telephone branch that the Mix and Genest Company have taken a leading part. The Mix and Genest telephones are not confined to the German Empire, but are now in use all over the world, several Governments having also exclusively adopted this type of instrument. The firm have a number of valuable inventions patented in all countries, and have lately given great attention to the development of new inventions, for which they have devoted a special portion of their works.

This year the firm has been converted into a joint stock company with a capital of 1,200,000 marks, in order to deal with the constantly increasing business, and a still further enlargement of the premises and introduction of further and more efficient plant is being provided for. The dividend for this year has not been declared, but is understood to be at the rate of over 9 per cent.

One of the great points of departure in the Mix and Genest telephones is the adoption of a combined form of

Table Telephone Stand in Drawing Room.

receiver and transmitter termed the double spoon-shaped telephone instead of the ordinary hand telephone. Thus, instead of having two instruments, there is only one, the speaking part coming opposite the mouth as the listening part is placed to the ear. The advantages of this shape are apparent, and our illustrations show some forms of the instrument as applied for office or drawing-room use. The adoption of this form by the German department has consequently caused most private firms to favour the same pattern, and the other forms have to a great extent disappeared.

The Mix and Genest microphone has had a considerable influence in the spread of interurban and long-distance telephoning in Germany, as by its aid clear articulation and ease of adjustment have been atttained. The Mix and Genest microphone has a diaphragm of pine wood (insulated on both sides against moisture by scales of mica), resting on an indiarubber ring, between an iron frame and a wood case. On a carbon plate attached to this rest three carbon rollers, pressed gently and firmly by a pad of felt attached to a movable spring.

Table Telephone Stand.

These instruments have been combined together to form a movable telephone stand. Ordinary office telephone stands offer inconveniences in that it is necessary to approach close to the whole apparatus, or else speak or shout in a very loud voice. These disadvantages are avoided in the Mix and Genest portable telephone stand, a fact which has principally contributed to its extended use. By means of this telephone a person is able to speak in any position he may chance to be in, and there is no necessity either to get up from a chair, leave a table, or rise from a sofa or bed, an immense advantage for invalid or infirm persons, who are thus enabled to use the telephone without distress and to converse in a low tone. This pattern of telephone is also highly serviceable to persons who might make more frequent use of the telephone, but who were prevented from doing so by the drawbacks of the fixed wall telephone. Physicians, bankers, lawyers, directors, and other persons would greatly appreciate this telephone, as well as ladies, who, as shown in one of the illustrations, can well and easily freely converse with friends, tradesmen, or order their boxes at a theatre or converse with their lawyer.

Mix and Genest Telephone, Office Pattern.

These telephones are made in a number of artistic and highly-finished patterns, either such as would be a becoming piece of furniture for an office, or a highly artistic wrought-bronze or gilt stand for private rooms. In Germany they are often used as second or third telephone in a house or establishment when once the consent of the Postal Department has been obtained. The Mix and Genest Company undertake the erection of large public telephone exchanges, and they have applied many of their instruments to shipboard and colliery use, as well as extensively to the military service.

SOME TESTS ON THE EFFICIENCY OF ALTERNATING-CURRENT APPARATUS.*

BY DR. LOUIS DUNCAN AND W. F. C. HASSON.

Several papers have appeared lately on the efficiency of alternating-current transformers, some of which have been of a more or less theoretical nature, while others have given the results of actual tests. I have never, however, seen any tests on alternating-current dynamos, excepting the experiment made by Dr. Hopkinson and Prof. Adams on a De Meritens machine used for lighthouse work. Even the converter tests have given such varying results that one can hardly be certain as to the real efficiency.

The introduction of the alternating system has been so rapid and is so rapidly increasing that people are apparently well enough pleased with the results not to bother about the smaller question of the reasons for them. But whatever the results may be, it is of value to know just where the losses in any system may come in, so that we may seek how to avoid them; if we are succeeding, it may enable us to increase the profits; if we are losing, it may help us to avoid further loss.

This apparatus, the measurement of which is the main subject of this paper, consisted of a Westinghouse 750-light No. 1 dynamo, with a No. 2 exciter and an outfit of 40-light converters. This apparatus had been presented by the Westinghouse Electric Company to the Johns Hopkins University, and was tested a couple of months ago. The workmanship of the machines is excellent.

The plant consisted of a 75 h.p. Armington and Sims engine, driving the dynamo and exciter through a Tatham transmission dynamometer. Engine, dynamometer, and dynamos were firmly secured to heavy parallel timbers, which served as a foundation. The converters were banked on a wooden framework at a distance of some 30 yards from the dynamo, and their primaries were permanently secured to the dynamo circuit, a switch in the latter serving to cut them off when desired. The ammeter belonging to the plant was put in this circuit and was read when efficiency measurements were being taken. The secondaries of the converters were taken to a switchboard, and then to incandescent lamps mounted on racks.

Power Measurements.—The Armington and Sims engine supplying the power worked regularly and satisfactorily, and the governor could be adjusted to give the speed required at the dynamo. The Tatham dynamometer was the one used for power measurements at the International Electrical Exhibition, held in Philadelphia in 1884, where its accuracy was checked by making with it a determination of the mechanical equivalent of heat. The result obtained in the latter measurement was 772·8 foot-pounds per degree F., and show that the dynamometer is practically accurate. A description of the experiments and of the instrument may be found in the report of the test made to the Franklin Institute, but it will not be out of place to briefly describe the apparatus here.

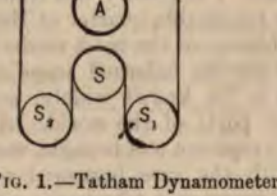


FIG. 1.—Tatham Dynamometer.

An endless belt, as shown in Fig. 1, passes over the driven pulley, S, to the shaft of which the engine is belted, round the pulleys S_2 and B to the driving pulley, A, and back over B_1 and S_1 to S again. The bearings of the pulleys B and B_1 are in cradles pivoted on knife edges, C, at their outer ends, and at the inner ends are connected by links at equal distances on the two sides of a knife edge which supports the scale beam, W. The outer side belt passes through the line of the knife edges, C, and therefore has no effect on the scale beam, but the tensions of the inner parts of the belt act directly on the scale beam, and as they are on opposite sides of the fulcrum they act against one another. The beam is so graduated that this difference of tension is read off directly in pounds, and this quantity—the difference of tension of the belt on the two sides of A—multiplied by its circumference and speed, give the horse-power delivered. A weight travels on the beam, W, and readings can be taken with great accuracy.

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* A paper read before the American Institute of Electrical Engineers, March 18, 1890.

Electrical Measurements.—The energy in the secondary circuit was measured by means of a Cardew voltmeter and a Thompson ampere balance. As it is not the custom to put a number of secondaries in parallel, each converter had its separate lamp circuit.

Before making an efficiency test the potential difference in the primary was regulated, there being a Cardew voltmeter in that circuit, and a separate measurement of the potential difference and current in each secondary circuit was made. When the test was actually in progress the voltmeter and ampere balance were used in one of the circuits, and the currents and P.D.'s in the others were calculated from the readings in this circuit together with the previous measurements. Both the voltmeter and ampere balance were accurately calibrated, the former being checked after each test, while the latter had its constant determined with both continuous and alternating currents. The P.D. at the terminals of a non-inductive German silver resistance in circuit with the balance was observed, when a continuous current was flowing, and also with an alternating current of the same period as that employed in the test. The current in each case was calculated from the resistance and P.D., and the results gave no appreciable difference in the constant for continuous and alternating currents.

The following table shows at once the order in which the test were carried out and the results :

HORSE-POWER ABSORBED AT VARYING E.M.F.'S.

—	E.M.F.		H.P.
	Dynamo.	Exciter.	
H.P. for exciter, field not made............	0	0	·34
,, field made..................	0	110	·75
,, dynamo alone	0	0	2·73
,, dynamo and exciter ...	0	0	3·04
,, ,, ,, ...	0	107	3·51
,, ,, ,, ...	1,376	124	12·5
,, ,, ,, ...	1,168	104	10·1
,, ,, ,, ...	1,099	105	9·60
,, ,, ,, ...	1,040	105	9·0
,, prim's of conv's on	1,216	105	12·0
,, ,, ,, ...	1,171	104	11·8
,, ,, ,, ...	1,107	104	11·12
,, ,, ,, ...	1,048	104	10·64

TABLE OF EFFICIENCY OF VARYING LOADS.

Approximate load.	Exciter.		Dynamo primary.		Converters.		Horse-power in lamp circuit.	Mechanical horse-power.	Loss in horse-power.	Efficiency.
	E.M.F.	Current.	E.M.F.	Current.	E.M.F.	Current.				
¼	105	9·4	1,107	10·	49·5	153·9	10·21	21·83	11·62	46·8%
½	104	10·5	1,107	18·9	49·6	338·4	22·50	34·4	11·90	65·4%
¾	101	11·	1,113	28·6	50·0	520·7	34·9	48·0	13·1	72·7%
Full	112	11·5	1,123	38·1	50·9	739·3	50·48	64·44	13·96	78·3%

EFFICIENCY OF CONVERTERS.

No. 8. 40-light converter.

No. of lamps.	Volts.	Watts in secondary.	Loss in watts.	Loss in iron.	Efficiency.
40	50·0	2,001	109	...	94·8
0	50·9	0	84	84	...

No. 4. 20-light converter.

No. of lamps.	Volts.	Watts in secondary.	Loss in watts in secondary.	Loss in iron, watts.	Efficiency.
20	48·8	952	106·	95·2	90·0%
15	52·2	817	114·8	108·9	87·6%
10	50·3	506	101·7	99·2	83·3%
5	51·44	264	109·4	108·7	70·7%
0	52·3	0	110·5	110·5	0· %

The efficiency of the converters was measured by placing them in a metal calorimeter, between the double walls of which water was allowed to flow. The temperatures of exit and entrance were observed, as well as the weight of water which passed through ; at the same time the current and P.D. in the secondary circuit of the converter were measured. A separate observation gave the radiation, which was of course allowed for although it was made as small as possible. A number of converters were experimented on, but I give but two of them—a 40-lighter, such as was used in the tests, and a 20-light converter, which was very carefully tested by two of my students, Messrs. Bliss and McKeen. In the latter case the observations were made at slightly different P.D.'s, and the results show that the loss in the iron varies as we would expect it to vary—that is, very nearly as the square of the voltage. The variation will not be exact, as the losses due to the reversal of magnetism do not vary quite as fast as the square of the induction.

I would like here to call attention to the fact that in an excellent paper read before this institute, Prof. Ryan, of Cornell, found that the losses in the iron of a 10-light converter decreased greatly as the load increased. This was accounted for by the fact that there was a jar (evidenced by the singing of the converter) at the higher loads, due to the attractions of the secondary and primary coils. While it is true that the losses in the cores of very small converters are not exactly constant, yet they are nearly so, and a large part of the decrease found by Prof. Ryan is due to the voltage being greater at the low than at the high loads

Looking now at the figures given in the tables, we are struck by two things : the very large amount of power absorbed in the core of the armature, and the very small loss in the converters on open circuit. The dynamo losses due to reversals of magnetism and eddy currents at the E.M.F. used in the test are no less than 6 h.p., while the energy due to reversal of magnetism and eddy currents in the 16 converters is only 1·6 h.p. Another rather striking thing is the almost constant ratio of primary and secondary currents over a considerable range. The maximum efficiency is about 78 per cent. It would seem that the losses could be divided into a constant part, and one varying with the currents, but this is not true with the older style and smaller converters of the Westinghouse Company.

Suppose we have a plant such as is described above, and use it for commercial lighting. Taking data from one of the local companies employed in supplying incandescent lights on this system, we have for two 2,500-light dynamos the following outfit of converters:

Size of converters.	Capacity.	Number in use.	Total lamps.
No. 1	5 16-c.p. lamps ...	44 ...	220
No. 2	10 ,, ,, ...	61 ...	610
No. 4	20 ,, ,, ...	43 ...	860
No. 6	30 ,, ,, ...	49 ...	1,470
No. 8	40 ,, ,, ...	64 ...	2,560

Total lamp capacity 5,720
Number of lamps supplied 4,557

I understand that the converters being added are of the larger sizes.

The efficiency of the 30-light converters does not differ greatly from that of the 40-lighters. The following is a load diagram of this plant, selected from a number of diagrams as giving a fair average curve. If we have our dynamo working to its full capacity, then from the above data we would have a converter capacity of 23 40-light converters.

If, as in our test plant, these converters are 40-lighters, or 30-lighters—for the efficiency of these two sizes is about the same—we would have a mean loss in our plant of, say, 10 h.p. in our dynamos $(9\ 6 + C^2 R)$, and in the converters about 3 h.p. $(2\cdot3 + C^2 R)$, or altogether about 13 h.p. From the above table we will have 750 lamps supplied, and taking the data from the load curve, the average load would be in the neighbourhood of 1,300. This corresponds to about 20 h.p., and the efficiency of the plant for 24 hours would be $\frac{20}{33} = 64$ per cent., minus the percentage of loss on the lines. This, in a properly installed system, should not average 2 per cent., so that the final efficiency would be 59 per cent.

A continuous-current dynamo supplying the same outfit of lamps, with a maximum loss in the mains of, say, 15 per cent., would have a greater average efficiency. But I wish to point out that the maximum efficiency of the two plants would be about the same, so that they would require the same capacity of station outfit, boilers, engines, dynamos, etc. When more than one dynamo is provided the efficiency is increased by using only one of them during the times of minimum supply, and always working as far as possible only a little below the maximum capacity of the machines.

Let us consider these results in view of the present condition of incandescent light distribution in the United States. I take it that what may be called domestic electric lighting is largely a matter of the future—it is certainly not a matter of the present. The majority—the great majority—of the lights in use are in shops, saloons, theatres, offices, etc. Most of the lights wired are in use at one time or another during the 24 hours, and the proportion of energy supplied to the total capacity of the lamps connected is much greater than it would be in the case of house lighting, where, on the average, only a small fraction of the possible lamp-hours are actually in use. Under these circumstances the scheme of alternate current distribution is very different from what it will be when the attempt is made to supply an entire city with light, as they are attempting to supply London at the present time.

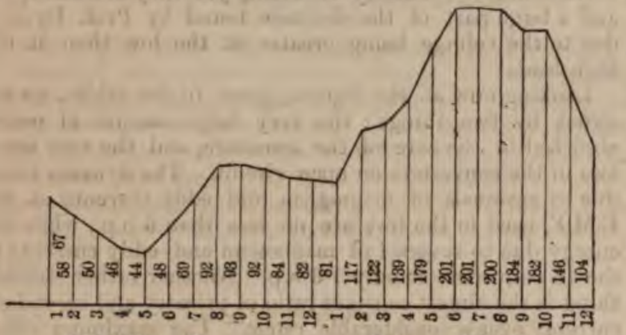

FIG. 2.—Load Diagram.

If the object of the lighting company is to supply the demand that exists at present, then a system employing a number of small converters is preferable. Such a system is flexible, and can be installed with a minimum expense for the more or less scattered demand which is presented in even the most closely settled town. I take it that this is the great difference between the alternating and direct systems as at present installed in this country. The former skims over an extended district, taking advantage of its great flexibility to absorb any business which can be got; while the latter settles itself in a densely-built centre, instals a larger plant than is primarily demanded, and works up a business within the limits of economical distribution. Therefore it is hardly right to compare the present systems of direct and alternating supply, as the latter has not been reduced to a point where entire districts are to be supplied.

To show the disadvantage of the present system for domestic supply, suppose we have an ordinary house, such as one of us would live in; it would be necessary to have a converter of at least 20-light capacity. The constant loss is, say, 100 watts; so, leaving out the C^2 R loss, we would have a total loss in 24 hours of $\frac{2400}{746}$, or about 3 h.p. hours, corresponding to say, 45 lamp-hours. Taking my own experience the actual number of lamp-hours used is about 30 lamp-hours during 24 hours, so the efficiency of the converter would be something like $\frac{30}{75} = 40$ per cent. It is evident that unless the losses in converters can be greatly decreased, a house-to-house distribution with a converter in each house would hardly pay.

It would seem, then, that if gas is to be really displaced and serious competition with it is to be attempted a different system of distribution must be worked out. We must replace the numerous small converters with one large converter supplying a comparatively extended district, thus decreasing the converter capacity, since the law of average can be taken advantage of, and greatly increasing the efficiency. If an extended secondary network is employed some of the converters may be disconnected from the mains at the turn of minimum demand.

Let us enquire for a moment how the increase in the capacity of converters will modify the designs with which we are familiar. In the first place, if we increase the linear dimensions of any type, since the radiating surface only increases as the square, while the volume increases as the cube of the dimension, then we cannot suffer the same loss per cubic centimetre of the iron for the large as for the small sizes. We must decrease the intensity of magnetisation, or we must decrease the periodicity.

Let us take a typical case. Suppose we have a transformer and double all of its dimensions. If we employ the same induction we will need but one quarter the number of turns in the coils, and as the cross-section of the space occupied by the wire is four times as great, the area of the wire may be sixteen times as much. As the length is twice as great, the resistance in this case is one-eighth. But the losses in the iron are, roughly, eight times as great; this we cannot allow, since the radiating surface is but four times as great; hence we must diminish the induction. In fact, we must so arrange things that the loss in the larger converter is only four times that in the smaller, in order to work at the same temperature. As at the low induction used the loss due to hysteresis varies nearly as the square of the induction, we may take it roughly that the large converter should have an induction of three-quarters of the smaller one. This will modify our figures. Instead of one-quarter the number of turns we will have one-third, and the resistance of the coils will be one-sixth instead of one-eighth, as we can allow four times the loss that we suffered before we can have, roughly, five times the output.

As a total result we have five times the output with four times the loss, or, as the C^2 R effect is not important as compared with the other losses, we can have six times the output with the same fall of potential in the secondary. That is, the efficiency of the larger converters will be greater than the smaller ones of the same design, and working at the same temperature, but the output per pound of metal will be less.

Suppose when we increase the size we decrease the number of reversals. Take a case, for instance, in which the dimensions are doubled while the reversals are halved, the maximum induction remaining the same. We could have half the turns in the coils, and as they occupy four times the space and are twice as long the total resistance would be one quarter, and for the same heating effect we would have four times the output.

If we take losses by eddy currents into account there will be a constant per cubic centimetre, provided the period and maximum induction are constant, and the thickness of the plates is unchanged, otherwise they will vary as the square of the induction with a constant frequency, or inversely as the square of the period, with a constant maximum induction. This, in practice, would make the values of the output for the larger currents given above somewhat greater. What I wish to show, however, is that we are limited by heating considerations and considerations of fall of potential in our secondary in the output of large converters. If we consider the properties of the materials of which converters are made, we would, I think, find it most economical to make converters that reach the temperature limit, except for the very smallest sizes.

Many of us have, I suppose, read Mr. James Swinburne's paper, read before the British Association at Newcastle last year, on the "Design of Converters," and have been struck by the fact that almost all of the converter dimensions given by him are impracticable, either on account of the disproportionate heating of the larger sizes, or the excessive fall of potential in the secondary. In increasing the size of dynamos we usually increase the output per pound weight; but there is the vital distinction between dynamos and converters, that losses occur through the entire mass of the latter, and as we increase the volume, we increase the losses in the same proportion. In the dynamo, on the contrary, there are practically no losses in the heaviest part of the apparatus—*i.e.*, the field-magnets. As a result, while we gain in efficiency in the larger sizes, yet we must decrease either our induction or the rate of reversal, and the output per pound is not increased

ON ELECTRIC MOTORS IN GENERAL RAILWAY WORK.*

BY DR. LOUIS BELL.

(Concluded from page 298.)

Taking this into account, it seems very probable that an electric elevated railroad could be built and equipped at a less cost than if it were to be operated by steam. The great ease with which small train units are handled on an electric system should of itself be the strongest possible recommendation.

The question naturally arises, How could we equip an electric elevated road to secure the best results? This opens a wide field for discussion, and I can only enter it to give you my own personal view on some points which might be of advantage. Personally, I do not believe in the single car as the unit of transportation: firstly, because it increases the cost of equipment enormously, and, secondly, because in running at a high rate of speed it is inconvenient to run independent cars as close together as is necessary to secure proper accommodation. On the other hand, I do not believe in long and heavy trains. The necessary speed for the service being known, I think the best general result would be obtained by using as many small trains as could be conveniently operated at the required speed. By small trains I mean trains consisting of motor car, and, say, two or three light passenger coaches. I am a firm believer in a motor car, rather than motors placed under each car, for the very practical reason that motors isolated and placed in a separate car can be given immensely better care than would ever be received by a motor hidden beneath an ordinary car. If we are to secure the minimum of repairs and the fewest possible number of breakdowns, I think it must be done by giving the motors steady and careful attention, and I believe this end can best be reached by a separate motor car so constructed that the motors and all the running gear can be under constant inspection. I see no objection to a composite motor car containing compartments for passengers, provided the above condition is fulfilled, but I should hesitate to use on a system requiring high speed and very frequent trains, motors so placed that they cannot readily and immediately be reached in case of accident. As to electrical equipment, I think the problem is not particularly difficult. The size of the motor to be used must be regulated by the train unit proposed. Perhaps for the unit suggested two 30 h.p. motors would answer as well as anything. It should be remembered that isolated as the elevated track would be, it would be practicable and safe to use higher potentials than is customary in ordinary street railroad practice.

The distributing conductors on an elevated system could be arranged whatever way would prove most convenient, quite irrespective of the present limitations. Neither would the amount of copper required be at all prohibitory. For example, take 10 miles of double track with the power station somewhere near the middle point, the wiring would, of course, correspond with the number of trains to be run, but working on a three-wire system, with track as balance circuit, the equivalent of two copper rods 1in. in diameter would serve to handle a very large equipment, and still give a high efficiency for the line. The weight of this conductor would be about 16 tons per mile of double track, certainly not a prohibitory amount. By using two power stations this amount of copper could be reduced to one-fourth. If the amount should still seem too large another interesting possibility appears. Would it not be possible to operate an automatic block system of series distribution? By dividing the double track into sections, and supplying these from one or more power stations, it would be possible to avoid most of the difficulties of series distribution, without sacrificing much in the way of line efficiency. We must remember in this connection that the principle of electric braking is easier to apply on such a system than it is on a system of distribution at a constant potential, as ordinarily practised. Electrical braking has not been put into operation in a commercial way, but some competent authorities have estimated that the saving from its use might be as great as 40 per cent. in power required. Such saving would be well worth effecting, even if it were less than the above amount, unless there should be good mechanical reasons to the contrary, and inasmuch as working upon the block system would do away with many of the objections to series traction, I think, to say the least, this line of operation is well worth careful investigation. In a great city like this rapid transit is becoming more and more a necessity, and now, before great investments have been made, is the time of all others to try to forecast the future, and see to it that the rapid transit given the city is the very best that modern enterprise can secure. I think we may feel sure, from what has already been done, that we need have no fear of the economy of an electric elevated system, and there is no good reason, therefore, why it should not be tried. People do not look forward with pleasure to having a smoky, hissing locomotive spluttering by their windows, nor do they contemplate with delight its train of cinders, ashes, and grease deposited on the heads of the long-suffering passers-by. Property owners do not enjoy the prospect of such a noisy, dirty neighbour as an elevated road operated with locomotives is, even at its best, and there is no reason why they should be called upon to tolerate the abomination, when nearly all the objectionable features can be removed, not by sacrificing anything, but by gaining at almost every point.

The reform cannot long be delayed. It is only a question of who will be the first to display the necessary enterprise and energy, and give this city a system of rapid transit suited to its needs, and to the age in which we live.

To sum it up, I would state my firm conviction that the most of us will live to see electricity come into extensive use in general railway work, certainly for special and suburban roads, possibly for long through lines.

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* Paper read before the Chicago Electric Club, March 17, 1890.

COMPANIES' MEETINGS.

SUBMARINE TELEGRAPH COMPANY.

A meeting of the Submarine Telegraph Company (in liquidation) was held at the offices of the Company, Throgmorton-avenue, E.C., on Tuesday last, under the presidency of Sir Julian Goldsmid, M.P., to consider the following report of the liquidators:

"The joint earnings of the cables for the three months ended March 31, 1889, and also their cash account from that date down to Jan. 31, 1890, are given herewith. The liquidators regret to have to report that they have been unable to obtain any increase in the offer for the Belgian cables, and an increase of only £3,000 for the French cables. The sum paid in respect of the Belgian cables was £9,999, and for the Company's French cables, £14,999. The sum paid for the steamer, leasehold properties, and furniture and fittings therein, was settled by valuation, and the valuation of the stores, batteries, instruments, etc., was made jointly by the officers of the Post Office and the Company. The Belgian Government has paid the liquidators £128 for the testing huts on the Belgian coast, and the French Government has agreed to pay £1,000 for the Company's land lines in France. The proprietors are, no doubt, aware that under the terms of the Company's French concessions, the salaries of the French clerks working the wires in the French cables had to be paid for by the companies, but from some oversight on the part of the French Government they omitted to send in to the companies at the time their account for the salaries of the clerks working the wires in the Havre cable from the year 1871 to 1883. The French Government discovered their omission in the course of last September. The claim was clearly one which could not be resisted by the companies, and the sum to be paid to the Government by the two companies was settled at the end of December last at £4,098, which sum, although not yet paid by the liquidators, has been charged in the accounts. The profit realised on the sale of the securities forming the reserve fund amounted to £26,319. With the sums paid by the Government and from the sale of the reserve fund securities, the liquidators have been able to return the capital to the proprietors in full. There now remains, as shown in the accounts, a balance of £26,840 to be yet disposed of, which will be further increased by the £2,000 caution money still in the hands of the French Government, when it is paid over to the liquidators. The liquidators now propose to make another distribution to the proprietors to the extent of 7 per cent. of the capital, leaving in the hands of the liquidators £3,164. 13s. 7d., which is subject, however, to the deduction of such sum as the proprietors may think proper to award to the liquidators for their services, and to the expenses that may be incurred until the close of the liquidation. The liquidators propose to distribute the balance remaining after these deductions, and the caution money, when they have settled accounts with the French Telegraph Administration, and with a person claiming compensation for alleged loss of light and air, which latter charge will be
amount."

The **Chairman**, in moving the adoption of the report, said that they had succeeded in getting some increase on the original offer made by the English and French Governments, though it was not so large as they would have desired. They now proposed to give the shareholders a further 7 per cent. upon the capital stock, which would make a return of 107 per cent. The total amount outstanding was £2,000, the caution money still in the hands of the French Government, and a balance of £3,164, which together made a little over £5,000. Out of this amount they would have to pay the remaining expenses of the liquidation, the costs in law and otherwise of a certain action brought against them by a Mr. Brunet for alleged loss of light and air owing to the construction of the Company's offices, and the remuneration of the liquidators. The amount that would be given to the shareholders on the final liquidation would be 1 per cent., leaving £1,800 roundly for the purposes he had named. Altogether, therefore the shareholders would receive £108 for their £100 stock.

The **Hon. H. R. Brand** seconded the resolution.

Mr. J. R. King protested against the payment of two of the liquidators, on the ground that they were rich men and formerly Directors of the Company; and he expressed his regret at the circumstances in which the Company was being wound up.

Mr. Simpson Rostron condemned the action of the Directors in so far as they had not taken the shareholders into their confidence the moment they found that a renewal of the concession was not to be granted by the French and English Governments, and also for having made the mistake, at the instance of the Post Office, of lowering their tariff to a point below what they were entitled to charge without making a distinct bargain that at the end of the term of their concession they would get it renewed.

Mr. Brand, in reply, said that up to within about six days of the time when the English Government interposed the Board had carried on negotiations to the point that the French Minister, as it were, had the pen in his hand to sign a renewal of the concession to the Company. The Board deliberately kept things secret because they thought they were bound to succeed. The liquidation had been forced upon them by the Governments of England and France, and they took the shareholders into their confidence as soon as their negotiations to obtain a renewal of the concession failed.

After some observations from the **Chairman** to the same effect the report was adopted, and resolutions were passed awarding £1,000 to the liquidators for their services, and enabling them, after the payment of all expenses, to distribute the balance of the funds at their disposal amongst the proprietors, and to destroy the books, other than the account books, of the Company.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The receipts for the past week amounted to £3,888.

Western and Brazilian Company.—The receipts of this Company, after deducting the fifth payable to the London Platino-Brazilian Company, were £2,964.

Montevideo Telephone Company, Limited.—The Directors have declared an interim dividend at the rate of 6 per cent. per annum on the preference shares for the half-year ended January 31, warrants for which are now posted.

West India and Panama Telegraph Company, Limited.—The Directors recommend a dividend of 6s. per share to December 31 ast on the first preference shares, and 27s. 6d. per share on account of arrears on the second preference shares, carrying forward £516.

Indo-European Telegraph Company, Limited.—This Company, after adding £10,000 to the reserve fund, recommend a dividend for the six months, ended December 31, of 17s. 6d. per share, making, with the interim dividend, 6 per cent. for the year, and a bonus of £1 per share, both tax free, making in all 10 per cent. for the year. The dividend and bonus will be payable on May 1.

Companies of the Month.—The following electrical companies were registered during the past month:

Durand Electric, Petroleum, Gas-Engine Manufacturing Company, Limited, £5 shares	£100,000
Electric Meter Company, Limited, £10 shares	50,000
International Exhibition of Mining and Metallurgy (Guarantee)	—
Key's Electric Company, Limited, £5 and £1 shares	15,600
MacMahon's Patent Electric Check System, Limited, £10 shares	30,000

Eastern Extension, Australasia, and China Telegraph Company, Limited.—This Company, in their report for the half-year December 31, state that the gross receipts, including Government subsidies, amounted to £264,103, against £238,854. The working and other expenses, including £24,620 for cost of repairs to cables and expenses of ships, absorbed £73,499, against £71,519, leaving £190,604, from which is deducted income tax, interest on debentures and contributions to sinking funds, and additions to staff quarters, leaving £144,758 as the net profit for the half-year, which, with £26,236 brought forward, shows an available balance of £170,994. One quarterly interim dividend of 1¼ per cent. has been paid, and it is now proposed to distribute another of like amount, making, with the interim dividends paid for the first half-year, a total dividend of 5 per cent. It is also proposed to pay a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the year 1889. The balance of £58,494 has been carried to the general reserve fund, which, after being credited with the interest on investments, received during the half-year, and a surplus profit resulting from a careful revaluation of the spare cable and stores in hand, and debited with £76,461 on account of the cost of the Western Australian cable, and further partial renewals of the Hong-Kong-Saigon cable, now stands at £710,113.

PROVISIONAL PATENTS, 1890.

APRIL 8.

5335. **Improvements in machines for insulating electrical conductors.** Henry Harris Lake, 45, Southampton-buildings, Middlesex. (Charles T. Stetson, United States.) (Complete specification.)

5343. **Improvements in telpherage systems.** Henry Harris Lake, 45, Southampton-buildings, Middlesex. (James Eveleth Maynadier, United States.) (Complete specification.)

5344. **Improvements in apparatus for measuring the strength and electro-motive force of electric currents.** Henry Harris Lake, 45, Southampton-buildings, Middlesex. (Madison Munroe Garver, United States.) (Complete specification.)

5368. **Improvements in telephony and in apparatus therefor.** Milo Gifford Kellogg, 24, Southampten-buildings, London.

5369. **Improvements in telephony and in apparatus therefor.** Milo Gifford Kellogg, 24, Southampton-buildings, London.

APRIL 9.

5400. **Improvements in dynamo-electric machines.** Richard Schorch, 89, Chancery-lane, London.

5409. **Improvements in electrical arc lamps.** Sigmund Cappilleri, Karl Kurmayer, Josef Goldberg, and Rudolf Latzko, 28, Southampton-buildings, London.

5420. **Improvements in the process of and means for the manufacture of cellulose with the aid of the electric current.** Carl Kellner, 46, Lincoln's-inn-fields, London.

5423. **Improvements relating to the transformation and distribution of energy by alternate electric currents.** Jonas Wenström, 45, Southampton-buildings, London. (Complete specification.)

APRIL 10.

5474. **Improvements in regulating and controlling the resistance of electric currents.** Henry Lyon and Henry John Leslie, 70, Chancery-lane, London.

APRIL 11.

5518. **Improvements in or relating to electric incandescence lamps.** Charles Price, 4, South-street, Finsbury, London. (Frederick Howe Hadfield, South Africa.)

5540. **Improvements in apparatus in which electrical measures are obtained by the aid of a wire or filament heated by the passage of a current.** Frederick Herbert William Higgins, 24, Southampton-buildings, London.

APRIL 12.

5558. **An automatic switch for use in telephone exchanges.** Robert Daniel Smillie, 154, St. Vincent-street, Glasgow.

5562. **Improvements in dynamo-electric machines.** Walter Emmott and John Hall Rider, Square-road, Halifax.

SPECIFICATIONS PUBLISHED

1889.

6544. **Electric lamps.** Goldston. 8d.
6578. **Arc lamps.** Hookham. 8d.
6675. **Electrically driven fans.** Watel. 6d.
8213. **Dynamos.** Lowrie and Hall. 8d.
8493. **Electric cut-outs.** Barber-Starkey. 8d.

1890.

2199. **Electro magnets, &c.** Currie. 4d.
2234. **Electric arc lamps, &c.** Nutting. 8d.
2364. **Galvanic batteries, &c.** Davis. 6d.
2464. **Electric light fittings.** Dorman and Smith. 6d.
2621. **Electrically driven fans.** Watel. 6d.
2819. **Galvanic batteries.** Lutcke. 4d.
2825. **Electrical safety fuses, &c.** White. 6d.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Anglo-American Brush	—	2½
— Pref.	—	1⅞
India Rubber, Gutta Percha & Telegraph Co.	10	18
House-to-House	4½	5
Metropolitan Electric Supply	—	5¾
London Electric Supply	5	2⅞
Swan United	3½	5
Crompton & Co., Pref.	—	5½
National Telephone	5	5¼

NOTES.

Torquay.—The sub-committee on electric lighting of the Torquay Local Board has been made into a standing committee.

Telephonic Telegraph.—The continental post offices receive and forward telegrams by telephone. In March alone 65,000 messages were sent in this way in Belgium.

Old Students.—At the meeting of the Old Students' Association at the Technical College, Finsbury, a paper on "Electric Traction" will be read by Mr. A. Reckenzaun.

The World's Fair.—The Senate has passed the Bill for holding the world's fair at Chicago, with an amendment providing that there shall be a naval review at New York.

Trusts in the United States.—The Judiciary Committee of the House of Representatives at Washington has ordered a favourable report, without amendment, on the Bill passed by the Senate to prohibit the formation of trusts.

Rome Electric Tramway.—The series electric railway for Rome is now nearly completed—the last ship load of material will be shipped this week. Three cars will be run on this line. A short telpher line of 100 yards is also to be erected at Rome.

Hanover.—The town authorities of Hanover have rejected the proposal of the Popp Company for the lighting of the town by the compressed air system, although the company strove to the utmost by means of promises and guarantees to obtain the concession.

Electric Bells in Asylums.—The offer of Mr. C. Bull, Stoke Newington, to supply and fit electric bells from the wards of the Eastern Hospital at a cost of £47. 10s., and to maintain the system efficiently for £8 per annum, was accepted by the Metropolitan Asylums Board.

Sprague Railways.—A list of the electric street railways installed by the Sprague Company prior to 1890 shows a total of 1,075 cars and 2,092 motors, distributed in 76 cities. In addition, they report the sale of 810 railway motors during the first 60 days of the present year.

Chelsea Exhibition.—The electric lighting at the forthcoming Military Exhibition at Chelsea is to be undertaken by Messrs. Davey, Paxman, and Co. This is the first time that the electric lighting of an exhibition has been contracted for by mechanical instead of electrical engineers.

Electric Railway in Russia.—We see that a correspondent of the *Times* corroborates the news we mentioned some weeks back of a long electric railway proposed in Russia from St. Petersburg to Archangel. The name of Messrs. Siemens is mentioned in connection with the enterprise.

Savoy Chapel.—The Queen has commanded an installation of the electric light for Her Majesty's Chapel of the Savoy. The schools of the Savoy have also been similarly provided. The work has just been completed by Messrs. B. Verity and Sons, of Covent-garden, and the current is supplied by the Metropolitan Electric Supply Company.

Key Signalling.—Dr. Marzari, of Milan, has constructed a signalling apparatus for maritime signalling by electric lamps at night, in which the necessary connections for red, white, and blue lamps are arranged in the interior to suit the combinations agreed upon. The letters are marked plainly upon the keyboard, and the proper connections for each signal are made by simply pressing upon the key.

Extension of the Telephone System in the North. The National Telephone Company have just completed their trunk lines from Inverness to Dingwall and Strathpeffer *viâ* Beauly, and have opened exchanges in Dingwall and Strathpeffer, which now become the most northern points touched by the telephone exchange system in Great Britain.

Electrical Trades Section.—At the annual meeting of the Electrical Trades Section of the London Chamber of Commerce, held on Monday, Mr. R. E. Crompton presiding, a resolution was passed thanking the members of the Chamber who had elaborated the scheme for forming the proposed labour conciliation board and undertaking to co-operate in the plan.

A Metropolitan Railway for Paris.—A length it is decided that the Parisians are to have a Metropolitan Railway. It is thought M. Eiffel in all probability will have the contract. M. Yves Guyot will receive M. Eiffel and examine the estimate which he has drawn up. The Rothschilds and other great banking houses are understood to show confidence in the scheme.

Deaths from Electric Wires.—In the House of Commons on Monday Sir M. Hicks-Beach, answering Mr. James, said the Board of Trade had received no official information as to the number of deaths caused in recent years by electric currents from wires in the United States. He was endeavouring to obtain some information, and when he came into possession of it he would lay it on the table.

Wolverhampton.—The new works of the Electric Construction Corporation at Wolverhampton, to which the old works of Elwell-Parker, taken over by the new company, will be removed, are now nearly ready and the transfer will take place very shortly. The erecting ground covers an area of some 12,000 square yards, besides, of course, workshops, foundries, and so forth on corresponding scale, and work is already reported sufficient to keep them all going.

Molecular Telephone.—After Pears and Holloway we suppose there is nobody much better known than Mr. H. H. Warner, the Safe Cure man. It appears from American papers that Mr. Warner, having sold his cure for five million dollars, is going to join his activities with Mr. G. F. Shaver and push the "Molecular" telephone. He has bought one half the interest, it is stated, of the Shaver Corporation at par, and will devote his great energies to what is hinted will be the future competitor of the electric telephone.

The Megaphone.—A note in the *Liverpool Courier* states that a new instrument styled the "Megaphone" has recently been patented by Mr. Robert Hope Jones, who is resigning his post as electrician to the Telephone Company in order to devote himself to perfecting the details, and, if possible, placing the instrument upon the market. By means of the megaphone it is easy so to magnify the human voice that it may be heard at a distance of many miles. The apparatus is also said to be applicable to bells, musical instruments as well as telephones.

Electric Heating.—The Burton electric heater for electric railway cars is being pushed commercially in the States as a practical and efficient device for heating rooms, offices, or electric cars. The company has just issued a circular showing the application of the method. They report that three amperes current is quite sufficient for the effective heating of a car on a 450-volt circuit, so that it will be seen that the amount of current used does not seem great when the simplicity and convenience of the heating apparatus is taken into account.

Paddington.—At last a decision has been come to in Paddington. The Vestry decided on Tuesday not to continue their opposition to the Metropolitan Company. The only competing companies left in the field were the House-to-House and the Kensington and Knightsbridge. The decision seems to have been arrived at purely on the question of price, the Metropolitan having offered lower terms than the other companies—viz., 7½d. per unit and 10s. a year for meters up to 50 lighters. There is also a small charge for transformers. The public lighting of Paddington was not considered.

Storage Batteries for Traction.—The question of weight is naturally one of the most important points of consideration in electric traction by means of accumulators, where the cells have to carry themselves as well as furnish power for passengers. Efforts are naturally constantly being made to reduce the weight, by increasing the output per lb. weight of the battery. Some months ago Mr. Desmond Fitzgerald obtained a rule of discharge of one ampere per lb. of battery, and he is now obtaining, under quite practical conditions, one and a half amperes per lb. of battery—not merely per lb. of element.

Dover.—At the meeting of the Dover Town Council, it was reported that the question had arisen whether the telephone company would have power to interfere with the Corporation's lines of wire, if they provided for electric lighting, and it is intended so to frame the provisional order that while the Corporation would not be empowered to interfere with the telephone company's existing wires, the telephone company would not be able to cause the Corporation to remove their wires, that might interfere with any wires that the telephone company might erect subsequently to the electric light wires being put up.

Telephone Signal.—A signal is asked for which when a telephone was rung up, whose proprietor was away, would at once give a signal stating that there was no one to receive a message, and how convenient also if some attachment could be devised for communicating the time the person would return to receive the message. It is perhaps not too much to ask telephone electricians to tackle these and similar problems: for in the time when the telephone is patent-free, it will be the refinements in facilities for business, as well as clearness of articulation, and the number and extent of connections, which will determine the patronage of the ordinary man of business.

Electric Pumping.—Messrs. Shippey Bros., Limited, have on private view a small American high-speed triple-action electric pump, which is being worked by an 8 h.p. Crocker-Wheeler electric motor, which will pump 1,000 gallons of water per day to a height of 100ft., or other quantities in proportion according to speed, at a cost, it is said, of less than 6d. per day for current. We learn that pumps are now being specially constructed with automatic regulators for working all descriptions of arc currents. This little pump is destined to fill a long-felt want for hotels and domestic pumping purposes in any district where current is obtainable from the central stations.

Cable Rates.—Sir John Pender, in his remarks at the meeting of the Eastern Extension Company, a short abstract of which we give elsewhere, states that the out-of-pocket cost per word for telegrams to Australia is 4s. 10d. We quite understand that the cost must be more than 1s., which amount has been proposed as the price to be levied for telegrams to Australia, but we are absolutely certain that a great reduction can be made upon present rates without detriment to shareholders. Perhaps Sir John Pender and his colleagues will undergo next month at Paris a process of enlightenment similar to that which awaited them at Berlin a few years ago. Why is the Eastern Extension a separate company from the Eastern? It would be good business to amalgamate them, and save even directors' fees.

Electric Train Signal.—Another electrical device has been brought out to afford communication between trains in motion and to prevent accidents. Batteries and the necessary connections are placed on each engine, a central conductor is laid parallel with the rails. Should two trains approach within a certain distance of each other an alarm is sounded in each cab on an electric gong, and the steam-whistle set blowing. The engine-drivers can stop the trains, and communicate, it is said, by telephones. They can communicate both when the engines are stopped or running. An automatic signal is also given should a switch be misplaced or a bridge burnt or washed away. Additional batteries are placed at the stations along the road, which work the alarms should those placed on the engines become broken. Mr. J. T. Odell, general manager of the Baltimore and Ohio Railroad, is president of the company.

Telpher Lines.—The new telpher line at East Pool, Cornwall, will be opened shortly. This line is to be used for the carriage of minerals. It is about 1¼ mile long, double track. The line is entirely automatic, the motors being arranged to take the current required. Some of the inclines being very steep, automatic centrifugal brakes are applied to keep the speed regular, and prevent the cars running away. No attendant or driver is required, the cars maintaining the requisite speed throughout the length, and stopping or starting at the turning on of the switch. A passenger telpher line of ¼ mile length is being erected at the Edinburgh Exhibition. The line is run on overhead wires on posts; it is a curved line, not rigid, and will therefore provide some of the amusing elements of a switchback. Fares will be charged of 3d. a journey, and double trains will be run. These trains also will be without drivers and automatic in regulation.

Barnsley Central Station.—The Park and Lighting Committee at the last meeting of the Barnsley Town Council recommended that part of Messrs. Robinson and Son's woodyard be provisionally chosen for the site of the central station of the proposed electric lighting plant. They also recommended that the Barnsley Gas Company be asked to submit amended terms for lighting the town, and reported their approval of the information provided by the borough surveyor for the guidance of electric lighting companies in tendering for the proposed electric lighting plant. Mr. J. H. Bailey enquired if there was any objection to give information with reference to the progress of the electric lighting. He did not wish for an answer if it would be to the detriment of the public interest to make it known. Alderman Blackburn said there was nothing to tell at present. They were getting on as fast as they could, but they had other people to contend with.

Weymersch Battery.—The Persian Bank, Austinfriars, has been fitted up with a Weymersch battery plant. There are two different sets of batteries and circuits, an arc and an incandescent circuit. A 400-c.p. Planet arc lamp is placed in the clerks' room, run from six batteries of six cells each. There are also 12 or 14 incandescent lamps, 50 volts, run by seven batteries, making in all 13 batteries. Several private installations have been also fitted up, with a considerable amount of success. One of the most noticeable is that for Mr. Sotheby, Park-street, Grosvenor-square, which has been working since October 1 last year. The battery supply seven to eight amperes for incandescent lighting. It is charged up once every eight days. Some 150 Weymersch batteries have now been supplied for various purposes. The Planet Electrical Engineering Company have fitted up several installations, and are under taking the manufacture of the batteries. Mr. Gatehouse is engaged upon another exhaustive and practical test of the battery in actual working to test the figures put forward as cost of maintenance, and the report will no doubt prove interesting reading.

The Electrical Exhibition at Edinburgh.—The final arrangements have now been made in connection with the opening ceremony at the International Exhibition in Edinburgh, which will take place at 1 p.m. on Thursday, 1st May. Their Royal Highnesses the Duke and Duchess of Edinburgh will leave King's Cross Station, Great Northern Railway, at 10 a.m. on the 30th inst., arriving at Edinburgh at 6.30 p.m., where they will be received by the Lord Provost and magistrates and the chairman and vice-chairman of the executive council, and conducted to the Royal suite of rooms at the Balmoral Hotel which has been specially reserved for them. On Thursday morning an address will be presented to the Duke in the Council-chamber by the Corporation, and the exhibition will be reached at 1 p.m. The executive council will entertain the Royal party to luncheon after the conclusion of the ceremony, which is expected to last about three hours. His Royal Highness will return to the hotel, and in the evening the Duke will attend a banquet to be given in his honour by the Corporation, leaving for London by the 10.40 train, East Coast route.

Fatal Accident on an Electric Railway.—A sad accident occurred on the electric railway at Budapest on April 21. A woman was knocked down by an approaching tram, caught by the wheels, and terribly mangled. A number of people who witnessed the occurrence made an attempt, according to a Reuter's telegram, to lynch the engine-driver and the guard, and it was only with difficulty that the mounted police rescued them from the violence of the infuriated crowd. The accident is particularly unfortunate at the early stage of the adoption of electricity in the town, but shows clearly enough the great necessity for care in the provision of safety guards on electrical cars. Horse cars have at least the advantage of having two intelligences, that of the horse as well as the man, to stop in case of need, and we must recognise the extra need in a mechanically-driven car for absolute safety from such accidents as that mentioned above. Electrical engineers would be culpable in the present state of the profession if they fail to recognise the necessity for extreme care for the safety of the public, and we trust the example of the unfortunate occurrence will not be lost.

Shallenberger Meters.—British electrical engineers will be interested to learn, as announced in the *Electrical World*, that the Westinghouse Electric Company has recently received an order for 750 Shallenberger meters of various sizes, which is the largest single order for these instruments that has come to the company since it placed the meters on the market. The order has been placed by the Metropolitan Electric Supply Company of London, which several months ago decided to adopt the Westinghouse alternating-current system for use in one of its large central stations in the great metropolis. Shortly after getting its first machinery started, the Metropolitan Company made a trial of the meters, and, being satisfied with the result, immediately ordered 350 of them. It has now seen fit to supplement the capacity of these 350 by an additional 750 meters, and when the latter order is received in London and put in use, 1,100 meters of the Westinghouse manufacture will be employed there. The Westinghouse Electric Company is naturally more than a little pleased at this evidence of appreciation for their machinery on the part of the English company.

Exhibition Effects.—The electrical exhibition, opened on April 7, at the Lenox Lyceum, New York, contains many special and interesting effects. Edison's apparatus and inventions, as shown in the Paris Exhibition, occupied a large space, and Mr. Edison himself attended, and a reception was given in his honour. A miniature electric railroad, with electric lights, a tunnel, switches, and every possible feature connected with an ordinary railroad, is represented on a small scale. The cars on this tiny road run day and night, and are very cleverly manipulated. The idea we mentioned a little while ago has also evidently been taken up here, for we hear that one very large room is devoted to glimpses of the twentieth century. In this a stage has been erected, and fitted with luxurious furniture and scenery. The scene represents a bachelor's quarters as it is supposed it will look in the twentieth century, fitted with all the modern appliances of that day, in their perfection—loud-speaking telephones, phonographs in connection with the clock to announce the hour, and like, gorgeous arrangements of electric lights, magic lantern effects by electricity, electric organ and piano, pneumatic tube connections, and so on. Numerous other electrical effects make the exhibition a highly interesting one to visitors.

Electricity on the District Railway.—The desirability of the introduction of electricity on the underground railway of London must forcibly strike three classes of persons, the public, the directors of the railway company, and the electrical engineers. The public anxiously wait, the directors are willing to adopt if workable, but not willing to spend money on trials. Someone must do this, and it is therefore the electrical engineers who must prove their beliefs and assertions. This has been fully recognised, and we are glad to say action is being taken to carry the object through. An electric line six miles long is to be erected on the District Railway, on that length of line from Acton to Hounslow, by the Series Traction Company. A *rapprochement* has been made, we understand, with the Thomson-Houston Company, and the details of the work will be arranged on the combined system. The line has some fairly stiff gradients for railway work: it is in open country and therefore requires poles and connections which in the town would be fixed to the tunnels, and to this extent be cheaper. The motors will be 150 h.p. The trains will be formed of two ordinary District cars of the railway company, with two special passenger cars each furnished with a motor in a special compartment. The total estimated cost is some £15,000.

Battery Resistance.—Messrs. Peirce and Willson in the *American Journal of Science*, according to the Chemical Society's *Journal*, have been experimenting on the internal resistance of batteries. They say: "The method of alternating currents did not give satisfactory results when the poles of the battery were connected with a conductor of moderate resistance for an interval of less than $\frac{1}{10000}$ of a second, it being assumed that the E.M.F. of the battery was the same during this short interval as it was immediately before when the circuit was open. By means of a special apparatus, the poles of the battery could be connected with shunts of various resistances for any interval of time between 0·3 and 0·0001 of a second, and during this interval a condenser of suitable capacity was charged by connecting its poles with the poles of the battery, and then disconnecting them. The charge received by the condenser was afterwards measured by means of a ballistic galvanometer. No signs of fatigue in the battery were observed, and the results were the same whether the battery was shunted for 0·5 or 0·001 of a second. The values for the internal resistances of various cells measured in this way were always greater than the values obtained by the method of alternating currents, and in most cases there is a tendency for the internal resistance to decrease as the strength of the current which the cell is delivering increases."

Central London Electric Railway Bill.—The consideration of the scheme for carrying an underground electric railway from Uxbridge-road to the Bank, at a cost of over three millions sterling, was resumed on Tuesday before the Select Committee of the House of Commons, under the presidency of Mr. Walter James. Mr. Greathead, the engineer, said there would be two tunnels 11ft. in width. There would be more accommodation in height and width than in the underground railways. The carriages would be entered from the ends, as in the tramcars, and they would weigh about one-half that of a Metropolitan train—that is, 80 tons as against 165 tons. There would be nine stations at intervals of about half a mile, and two termini. The total capital and borrowing powers would be about three and a quarter millions sterling. There was not the slightest fear of vibration or noise above ground, the average depth from the surface being 50ft. There would be no blow-holes, as in the metropolitan railways, where steam was used, and the locomotive engines would be entirely driven by electricity. Dr. Hopkinson, the electrical engineer, said that the cost of generating power and locomotive engines and other plant would be about £275,000. It is expected that the enquiry will go on for about a fortnight, nearly the whole of the parliamentary bar being engaged.

Electric Omnibuses.—It will be remembered that we created a great deal of interest, not only in this country, but in America and on the Continent, by the announcement of the trial running of an electric omnibus in the streets of London. We are now able to state that in a few weeks a line of electric omnibuses will be established, and commence running for passenger traffic as ordinary omnibuses without rails from Charing Cross to King's Cross. The route will be up Regent-street and along the Euston-road, so that the fashionable world as well as the workers will have a chance of seeing and riding in the cars. The omnibuses will have 16ft. bodies, much of the same size as the usual ones, but less in total length, taking in equal about half the length of the horses. Six inches more in seats will be allowed to each passenger, a comfort to be largely appreciated. Seats will be both inside and out, and 26 passengers will be carried in each. There will six omnibuses on the route, and a charging station is being erected at King's Cross. The omnibuses are on the system devised by Mr. Radcliffe Ward, and driven by accumulators. Electric delivery vans for heavy traffic will also, it is expected, be introduced, and charging stations will probably be erected at various convenient business centres. An electric butcher's cart is now practically finished, and has been constructed for, and will be used by, a well-known pork butcher.

Marylebone.—At the St. Marylebone Vestry, a communication was received from the Metropolitan Electric Supply Company, Limited, accepting the conditions imposed by the Vestry in relation to the laying of the company's mains in the parish, and asking for an extension of the time expressed in the agreement between the Vestry and themselves for the laying of the mains. Sir E. Goldsworthy congratulated the Vestry upon the conclusion of this question. The Parliamentary Committee had got the Vestry into a very nice mess, but the common sense of the majority of the Vestry had pulled them through. To put everything in proper form, he would move: "That the applications of the company for an extension of time be granted subject to the terms and conditions being agreed upon, and endorsed on the agreement, and sealed, after first being approved by the Works Committee." Mr. White objected to the question being referred to the Works Committee. It was in the interest of the public that there should be no further delay in this matter. Mr. Reed also contended that if this were done the delay would be considerable; they would have to wait for the committee's report, and then there would be the delay in discussion. He would move as an amendment that the last eight words of the resolution be struck out. Upon a show of hands the resolution was carried by 32 to 20.

Series Motors.—One of the most interesting exhibits to electrical engineers at the Edinburgh Exhibition is to be a set of three constant-current motors run in series. It has been denied that this can be done successfully, but we are to see these machines working at the exhibition. A Statter dynamo delivering 60 h.p. will be used to drive three 18 h.p. series motors. The generator gives 50 amperes and 1,000 volts—that is, will vary between the pressure required by the motors in all, up to the maximum of 1,000 volts. The current is absolutely constant. The motors are governed by shifting the brushes by an arrangement of dead-beat centrifugal governors. The work to be done by these motors, any or all of them, can be varied within their powers, and the speed is found to remain constant within 2½ per cent., and without sparking. The mains are connected direct to the motors, and the motors take the energy they require. This does away with all switch gearing. The arrangement will make the employment of series motors for changing work very convenient. One of the motors is connected to an electric hoist or crab. The two others will drive shafting. This method, also, of regulation by shifting the brushes by hand in one of these motors is found to be eminently satisfactory for electric hoists. All the regulation is done by one handle moving the brushes. One position gives just enough torque to resist the weight to be raised. A movement reduces the torque and lowers the weight gently. A motion the other way, raises it gently; still further, raises it quickly, the whole regulation being under complete control.

Westminster.—The Westminster Electric Supply Company are actively proceeding with their operations for supply of lighting. It will be remembered that this company have provisional orders for the extremely rich and populous districts of Westminster, Belgravia, and Mayfair. The distribution is entirely underground, on the low-tension and three-wire system, with accumulators. The company have had for some time a small station at the back of Victoria-mansions, supplying some 800 lights. Another temporary station supplies the Houses of Parliament. A large station is to be erected at once at the wharf behind the Houses of Parliament for some 20,000 lights. The company's largest station will be in Eccleston-place, quite in the centre of the district of Belgravia, and this will be also proceeded with as soon as possible. The site for still another has been selected and arranged for near Mount-street, in the very centre of Mayfair. In all these districts, it will be seen, the London Electric has also supplying powers, and a pretty determined competition is likely to ensue between the high and low tension supplies. The London (from the Grosvenor) are in the field in a good deal of this district already, and possession, as we know, is nine-tenths of the law. But the Westminster avow themselves certain of a very large degree of support on account of the tension being low. Many mansions, it is said, are only waiting for the system to be brought to their doors to change their allegiance, from a holy fear of high tension. Mr. Edison's well-known opinions are freely quoted, and Mr. Ferranti will, in some cases, doubtless require powerful arguments in the shape of cheapness or safety devices to stem the opposition. As has already been alluded, Prof. Kennedy has found the demand on his time so great that he has resigned his position of consulting engineer (which he held in conjunction with Sir William Thomson) for that of acting engineer to the company.

Birmingham Tramways.—The Birmingham electric tramway is now very nearly complete, and will probably begin running shortly. The charging station is erected and fitted, and the cars are receiving the finishing touches. The line is one which offers all the conditions to be overcome in a successful line: it is through a crowded and populous town, the service is required to be a quick one, and the gradients, especially that up Bradford-street, are exceedingly severe. The trials with the type of car finally adopted have proved extremely satisfactory to both the tramway company and the electrical engineers. It is a little interesting from various reasons to note the way in which the enterprise has developed and assumed its present shape, not the least difficulty having been the extreme cautiousness, the almost absurd cautiousness, of the tramway company. They would have no new factors introduced; the special capabilities of electricity were not so much considered as the strict adherence to conditions already well known and provided for in their steam engines. This attitude and the conditions which were imposed has hindered the fulfilment of the work by many months. In the first place, the company insisted, against electrical advice, upon having an electric locomotive instead of self-contained cars; and further insisted upon having a locomotive which should replace under the same conditions the old steam locomotive. This was done and one of the old cars was drawn with considerable success. The company next insisted that the actual new car which could be run with the locomotive, if adopted, should be first constructed before definite resolve was arrived at, and after months were spent and this was done, finally the advice of the electrical engineer was accepted and self-contained cars were decided upon and ordered. The test car has been working satisfactorily, carrying passengers constantly for some time. Twelve cars in all have been ordered and these are now practically ready, and the line will therefore be worked entirely on this principle. When the cars are running, the result cannot but have a still further effect in helping forward the extensive movement that is setting in in England for electric traction.

Ozone at the Chemical Exhibition.—On Tuesday, April 14, a most useful institution in the shape of a permanent chemical exhibition was inaugurated at Manchester. The opening address was delivered by Mr. Ivan Levinstein, chairman of the Manchester Section of the Society of Chemical Industry, and chairman of the Chemical Committee of the Manchester Chamber of Commerce. The object of the exhibition, said the president, was not only the illustration, by specimens and otherwise, of the results of chemical operations and kindred processes, but also the illustration of the appliances necessary for arriving at these results in the best and most economical manner. In addition to bringing together the various exhibits of chemicals and products of a similar character and the necessary machinery for their production, the promoters have set aside in the building for the convenience of visitors writing-rooms, a smokeroom, lavatory, telephones, etc., with a view to facilitate the transaction of business and ultimately make use of this part of the building as a kind of chemical exchange, an idea which he hoped might be realised before long. Other useful attractions, such as a very comprehensive technical library, including a number of periodicals and trade catalogues, ought to assist in making the exhibition building a favourite meeting-place of many who were interested in the chemical trade. Most of the exhibitors are specially connected with the chemical trade. We notice Messrs. Galloway and Mr. Joseph Aird show boilers and tubes, and other manufacturers present objects interesting to the chemical trade. Several exhibits of acids and other chemicals useful in electrical work are shown, and Messrs. C. R. Lindsey and Co., of Clayton, have a large exhibit of peroxide of lead. But perhaps the most novel and interesting exhibit is that of Mr. Ernst Fahrig, St. Helens Ozone Works, Plaistow, of ozonised products produced by the generation of ozone by means of electric currents. Esparto pulp is shown bleached by the ozone manufactured by this method. Where this agent is employed absolute whiteness and fixity is assured; in fact, an imperfectly bleached material will become whiter by standing, as though the residual ozone were slowly spending itself, and gradually bleaching the fibres. Ozonised water is shown, suitable for killing microbes and for sterilising purposes generally. Ozonised oil is used in medicine and in the preparation of linoleum and floorcloth. A further specimen shows what is called "ozone ammoniated lime," the peculiarity being that a considerable quantity of nitrogen is said to be fixed in combination with the line, and "ozone oxidised mangan," a high oxide of manganese, is formed by the action of ozone on a lower oxide. A bleached solution of sugar is shown, the liquor of which, before treatment with ozone, was jet black. The bleaching may be performed either before or after boiling, and is also applicable to dry sugar of all grades. We may mention that the electrical production of ozone in immense quantities, evidently capable of many important chemical applications, is receiving considerable attention from chemists and electricians both in this country and on the Continent

CONFERENCE OF ELECTRICAL UNITS.

[Authorised Abstract.]

An ordinary meeting of electrical units was held last night in the new extension of the polar area.

The chair was taken at 7.46 by B. A. Volt, Esq., and the proceedings commenced with the singing of a hymn specially composed for the occasion by one of the Watts (D.Sc.):

How doth the little busy volt
  Increase the ampere-hours,
By exercising all the day
  His mighty storage powers.

How cheerfully he fills each cell,
  How neat he spreads the charge,
And labours hard in changing well
  Di-oxide to litharge. Ampere.

The president then opened the meeting in the following speech: "Fellow units and constants,—It is with the most sincere pleasure that I look back on the great progress we have made in the last few years, partly, no doubt, owing to the enthusiasm of our younger members, but chiefly, I think, to the high example of truthfulness and accuracy given us by my honourable friends the *established standards*, whom I now see gathered around me." [The committee was composed chiefly of standards, who were seated round the president in a Gramme ring.] After some further remarks addressed chiefly to the younger members, the right honourable president proceeded: "Before I close this perhaps tedious address, I feel bound to pay a humble tribute of respect to my venerable and esteemed contemporary the Siemens unit, little known, perhaps, to the new generation since he has retired from active service; but let me tell you, gentlemen, that but for him we might still be running along naked conductors in a helpless state of uncontrolled barbarity, scarce knowing whether we were quantities or differences of potential, instead of which we see everywhere, or nearly everywhere" (here the president looked pointedly at some young alternate volts who were sitting in series near the back of the hall) "order and law. I even hear with pleasure to-night that some of our most prominent members have organised a society for the conversion of foot-pounds. The first meeting will be held to-morrow night. Subscriptions are earnestly invited, and I am requested to add that contributions of cast-off insulation or disused lines of force will be thankfully received. I will now detain you no longer, but call upon my honourable friend the Siemens unit for a few remarks, by which all of us are sure to profit."

The Siemens unit, in a voice choked by self-induction, thanked the chairman for his kind references to him, and said: "I am now an old unit who have borne the current and heat of the day (the latter proportional to the square of the former), my insulation is getting thin and grey, and I now look forward to that quiet and peaceful ohm, 'where potentials cease from troubling and the amperes are at rest.' I would erg(e) you, then, to direct your energy along legitimate channels, eschewing the by-paths of modern Ferrantic enthusiasm. I am sure that my old and respected friend the continuous-current dynamo would never have so far lowered his efficiency as to consent to supply current to a tubular conductor for the base and vibrating purposes of high tension and homicidal transformers. I would beg the younger members to take pattern by him, and not to be led astray by the brilliant but erratic results obtained by that erg-destroying invention of the evil one, the alternate-current dynamo. My earnest prayer for each member present is that in times of trial and trouble, when short circuits and earths gather round your devoted heads, you may be sustained and comforted by self-regulation, and that your observed characteristics may approach nearer and nearer to the ideal which has been plotted for your guidance and direction. I trust that the young alternate volts whom I see around me will forgive me if I have in any way hurt their feelings, but I feel strongly that a volt who has persuaded himself that the path of duty is a sine curve is cherishing a most fatal delusion, which must inevitably lead to the destruction of all that a unit holds dear in this system and in the next."

Here a young volt was led out by an elderly Rhumkorff coil in a violent fit of hysteresis.

Scarcely had the honourable gentleman tottered to his seat when an alternate volt sprang to his feet and poured out his indignation in a torrent of words: "I wish to speak with the utmost deference of the honourable standard who has just sat down, but I cannot be calm. My potential rises when I think of the insults heaped upon me and my family by an antediluvian unit however respectable. Why, I say, does he wish to hint that we are upstarts? The first dynamos who ever lived gave alternate currents The natural condition of a volt is to alternate, and yet we are despised and cried down, simply because we refuse to outrage nature by the artificial aid of a meretricious commutator. There is a violent prejudice against us; coiled resistances refuse us passage; many established instruments decline to measure us; there is even a base conspiracy amongst motors, who have united to lock us out, but I have no fear; Nature will triumph over foolish and malicious oppositions alike, and the glorious time will come at last, when potential will be infinite, conductors attenuated to a geometrical line, and amperes a thing of the past."

The next speaker was the ohm, who said she "could not but deprecate the tone of violent and high-tension personality which had been introduced into the discussion by the last speaker. His accusation was that the ohms were wanting in permittance and conductivity. She ventured to state that it had been demonstrated times without number that their coy resistance could be overcome by the steady attentions of a constant current, but she considered that the fickle and false attentions, or rather persecutions, of an alternating current, whose value at the best was but a mean one, were but justly requited when they met with impedance." The speaker wound up an indignantly eloquent peroration with these noble words: "The manly and respectful attentions of a constant current we will receive with that courtesy which is their due, but the erratic, dishonourable, and dishonouring seductions of a wobbling alternator we will never permit. No, sir, we have too much self-induction."

At this point the proceedings were interrupted by a violent disturbance created by an aged and respectable ohm who, amidst some confusion, screamed out that an ampere was crawling up her. He presently appeared at the top and was then seen to be in a state of inebriation. The scandalised president just mustered sufficient potential to gasp out an enquiry as to how he got there, to which the ampere coolly replied that a volt had given him a "leg up," and there the matter had to rest; the refractory ampere could by no means be got down, as the back E.M.F. had just left the room.

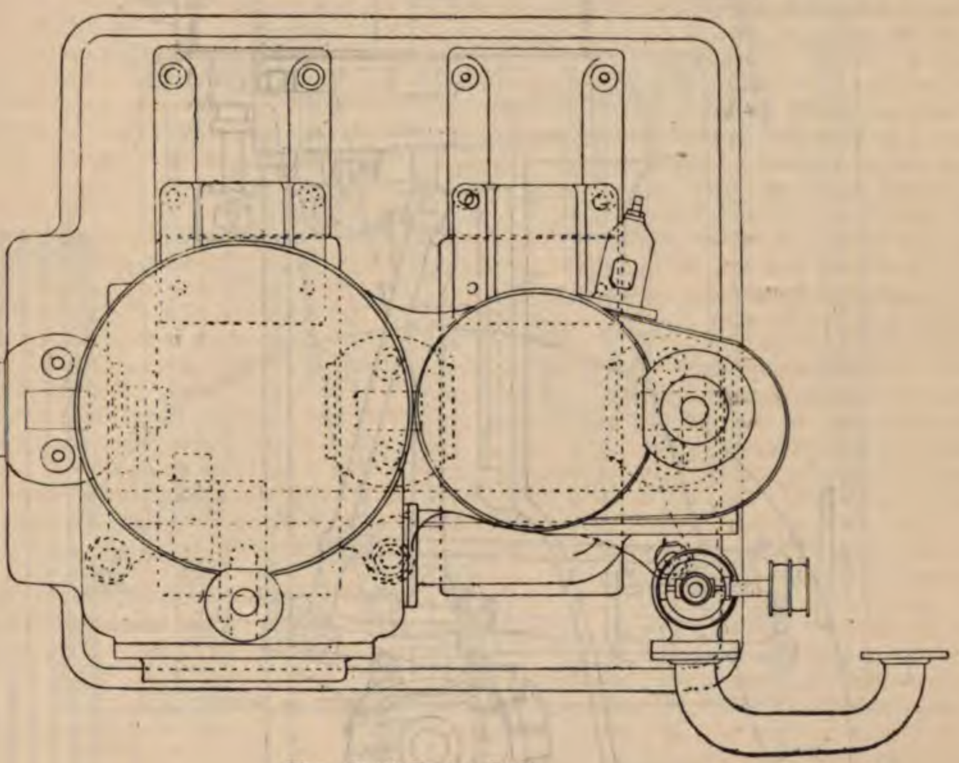
After this it was found impossible to proceed, as all the ohms were tucking their skirts round their legs and screaming violently. Accordingly the president, after one or two fruitless attempts to restore order, switched out the meeting. U. C.

A PERFECTED CONDUIT SYSTEM.

We have been favoured with an advance view of the details of a new system of electric traction for tramcars by means of underground conduits, which we may safely say will cause very considerable excitement in the fields of electric traction, and may in all probability prove to be a complete, simple, and comparatively costless solution of the problem of the conduit system for electric tramways. It may be considered to have ingeniously overcome the numerous and considerable difficulties that have hitherto lain in the way of the extensive development, which is so much desired, of the direct system of supply for electric cars in England.

It is well enough known that an overhead system is practically useless for English towns; public opinion and the local authorities are dead against them. The systems to be employed, therefore, are either underground conduits or the accumulator system. The latter has its advantages and also its disadvantages, among which are the loss in conversion, the extra weight to draw, and, above all, the expense in maintenance of the batteries. Underground conduits to contain the conductors have therefore been proposed to utilise the evident advantages of direct-current transmission Not many examples, however, have been practically carried out, that of Mr. Holroyd Smith at Blackpool and the series system at Northfleet being, we believe, the only examples in this country. There are not many conduit lines either in America—they might be counted on the fingers. The high first cost of the plant—conduit, cables, connectors, and the whole complicated series of electrical apparatus, with the collectors on the car—has been one great reason for this. Not less has been the difficulties both of obtaining a high insulation underground, and of keeping the connections, etc., in order.

The system we now allude to, and of which further information will be forthcoming shortly, has been designed after a long series of experiments and trials to obviate, in a very great measure, the whole of these disadvantages. The system, in effect, is so absurdly simple, so adaptable in its application to the desiderata, and withal so easy of application, that it seems rather astonishing it has not been hit upon and developed before. Not, however, that there are not ingenious points enough about it to make it quite clear that it is by the careful and thorough elimination of the disadvantages one after the other that has led to this apparent simplicity—a simplicity that is, in fact, a complication with the odd factors cancelled out. In the first place, the new system is, for a conduit system, magnificently cheap. In the cheapest of all other conduit systems the cost has been at the very least £1,000 a mile for the electrical equipment, that is, after the lines and conduit itself have been laid. In the new system to which we refer, to be known as the Waller-Manville system, the electrical equipment—cables, insulators, crossings, boxes, collectors, everything besides the conduit and rails—can be supplied at a quarter that sum. The details, moreover, are so arranged that the conduit once laid (or changed from a steel cable line) the whole electrical equipment could be inserted in a single night, say, for a line five miles long, or, for that matter, practically any length with a greater number of workmen. So that to change from a steel cable system to an electric system would, after a few alterations at the side of the conduit, be a question of a night, with no stoppage of traffic. This in itself is a sufficient recommendation. But more follows. It is well known the great difficulty is insulation in underground conduits. To obtain the highest insulation we should desire the conductor to be in air space, with supports at long intervals, and for the best result the insulators should be oil insulators. All these points are obtained in the new system. The insulators allow of easy inspection without disturbing the conduit, and also of frequent cleaning if desired. With regard to contacts, again, the conditions necessary are simplicity of electrical parts, flexibility of contact to allow for irregularity of road-bed, and yet always perfect contact for the passage of the current, with no chance of stoppage through mud or dirt. This also is obtained in the simplest possible way. Underground crossings of conductor are also entirely done away with, "spring-jacks" and similar complicated collectors are absolutely abolished. The system is equally adaptable to double circuit or return circuit by the rails, and has an additional advantage that it is perfectly easy to connect to an overhead system at any desired point—such as the outskirts of a town. The whole conduit can easily be swept out by a brush attached to the first car in the morning, without interference with the conductor.

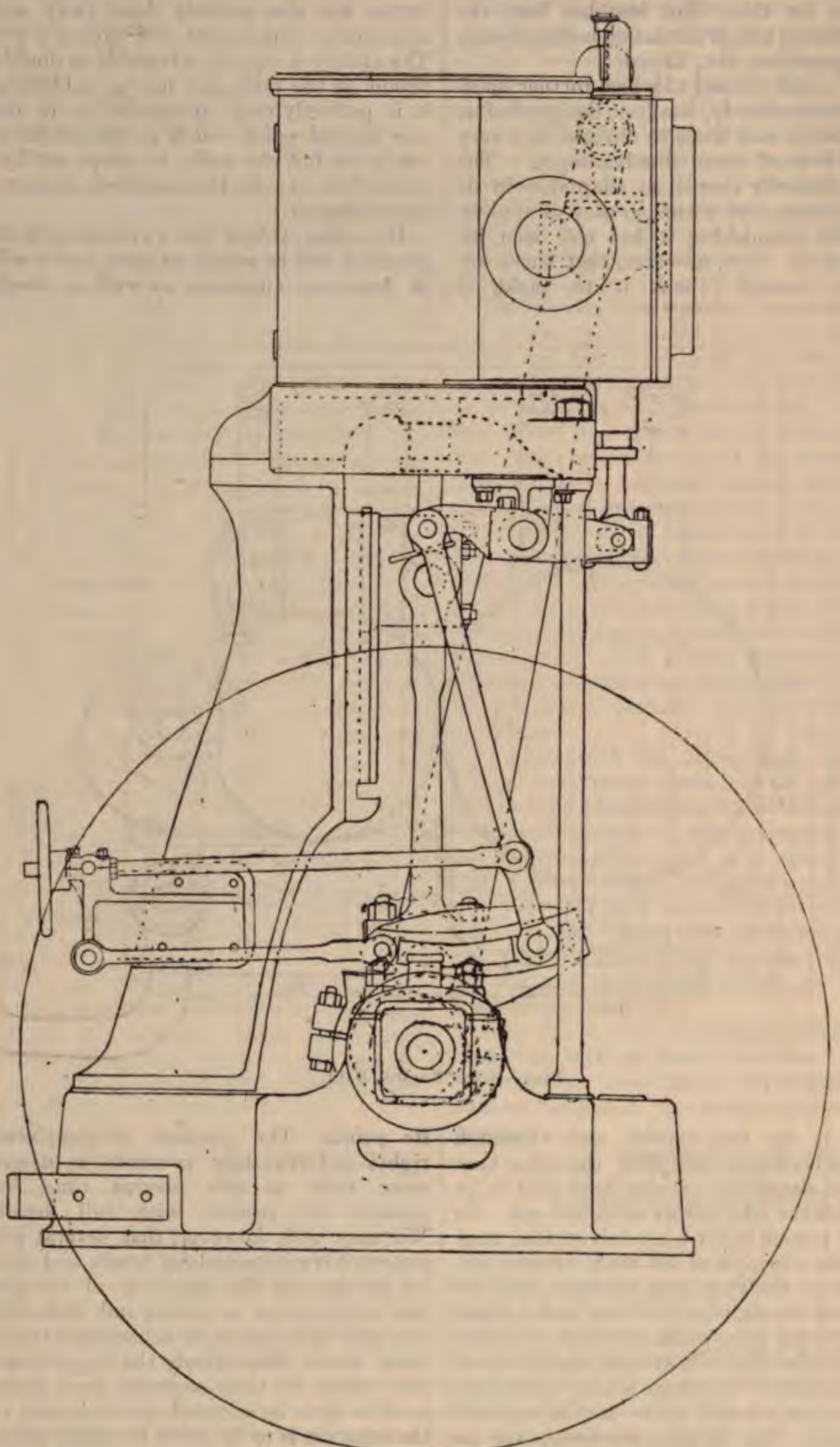

Plan—Brush Engine, Bath.

It is quite evident that a system with these advantages, if practical, will be widely adopted, and it will be to the interest of American engineers as well as English to investigate its points. The question of completion of the patent rights unfortunately prevents us describing the system more fully at this present time, but we hope to present our readers with full details very shortly. We may add, however, that several prominent electrical experts have inspected the details, and expressed great praise for its idea and the simplicity of the parts, and to add to this we are given to understand that although the system has only been known to others than the inventors for about three weeks, that already the corporation of a large town, after advice by their engineer, have signified their decision to allow it to be adopted on a new line to be erected, and the contract is to be given for eight miles of line.

Electric Lantern Microscope.—Great interest was manifested at the medical congress, recently held in Vienna, in Prof. Stricker's electric microscope, by which microscopical preparations under a magnifying power of 11,000 linear were made visible to an audience of 300 persons. The pulsating heart of a dog and the heart beats produced by suffocation were successfully demonstrated, and the experiments convinced the spectators that the teaching of natural science would be greatly assisted by this appliance.

MASSINGHAM'S CENTRAL STATION AT BATH.

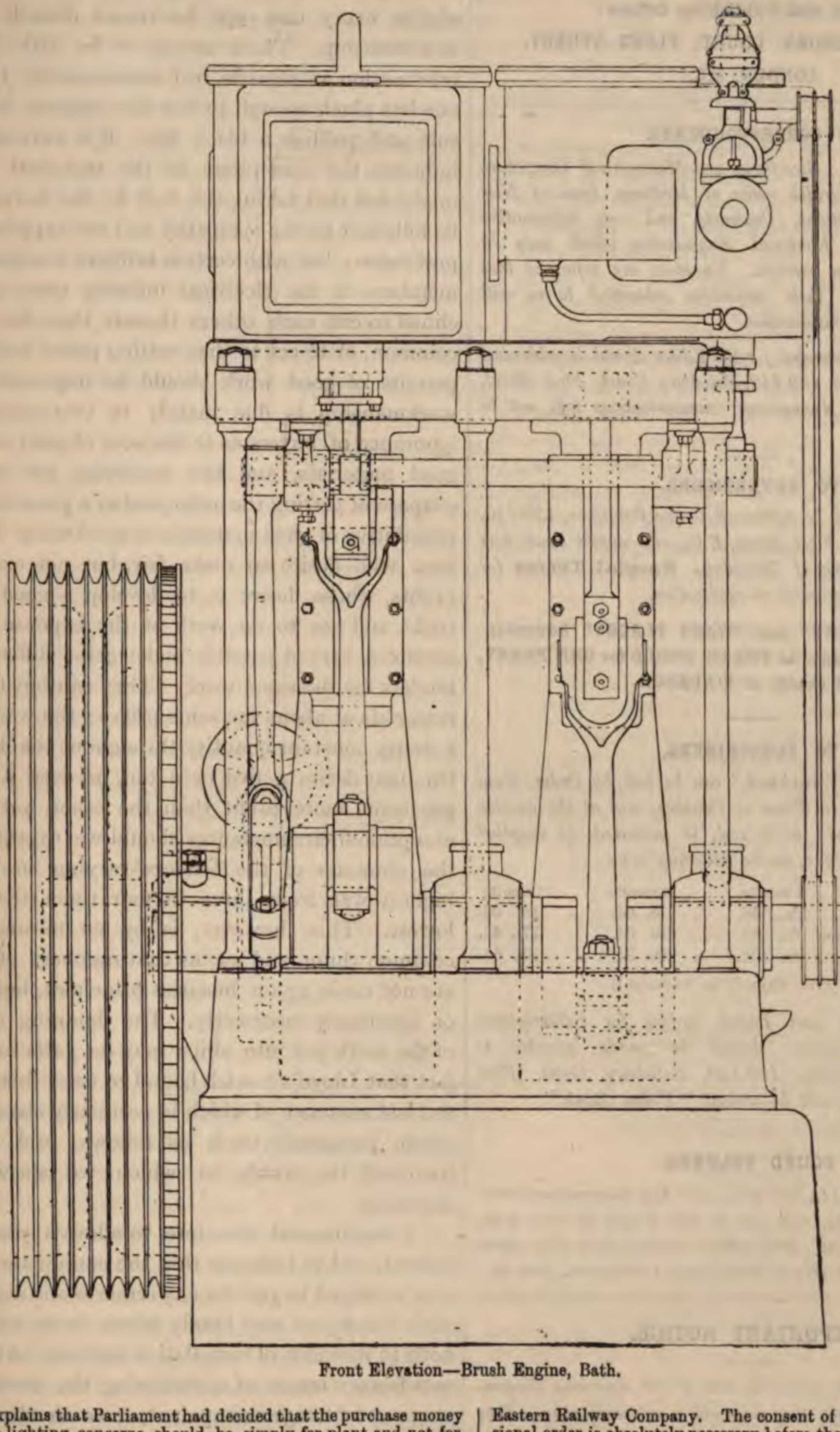
It is well known to most of our readers that Mr. Massingham has been successful in obtaining the electric lighting of Bath, and following on his experience at Taunton has introduced a mixed system of arc and incandescent lighting. The Thomson-Houston system is adopted for the arc lighting, and the apparatus has been supplied by Messrs. Laing, Wharton, and Down, while the Brush Company has supplied the whole of the engines and the dynamos and transformers for the incandescent lighting. We give herewith plan and elevations of the engines supplied by the Brush Company. The engines, of 150 h.p., have been constructed at the Falcon Works, and show another phase of the energy of this company. It will be remembered that the Falcon Works were acquired only recently in the reorganisation of the company, and the Bath work is among the first carried out under the new organisation.



Side Elevation—Brush Engine, Bath.

THE CHATHAM, ROCHESTER, AND DISTRICT ELECTRIC LIGHTING COMPANY.

In connection with the provisional order of this company, an arrangement has been come to by which the appointment and remuneration of electric inspectors shall rest with the local authority and not with the County Councils. With respect to the "length of life" of the company, the committee of the Chatham Local Board of Health have had the particulars formulated below by Mr. Norman (solicitor to the company). The company ask the Local Board to withdraw the limitation put upon their consent to the provisional order as to the time the company should run—this being fixed at 21 years, whereas 42 years is allowed by the Act of Parliament of 1888. Now, in 1882 the first Electric Lighting Act was passed, and by this it was provided that at the expiration of 21 years the local authorities might, if they thought proper, purchase the undertaking, not in the same way as they might take over a gas or a water undertaking, by buying the plant and goodwill, but by ascertaining the value as it stood and allowing for depreciation of plant. If an electric lighting company makes its way, and was successful at the end of the period of 21 years, they would receive for their property its cash value, having to lose the cost of experiments made and the value of any plant which may have been discarded. It was therefore essential in order to cover the expenditure, and to protect the shareholders, that a reserve fund should be provided for the repayment of the capital. The opinion of Sir Frederick Bramwell on the 21 years' limitation is put in, and Mr. Norman explains that Parliament had decided that the purchase money for electric lighting concerns should be simply for plant and not for goodwill at all. The result of this was that prudent investors would not risk their money in electric light companies, as they could not, under such conditions, see their way clear to obtain any benefit, and consequently, in 1888, as a result of adverse criticism, the Act was amended, the period over which a company might exist being extended to 42 years, this being considered a period affording a reasonable opportunity for a company to pay a dividend and get back its capital. Local authorities are in no way obliged to purchase, but if at the end of 42 years might do so at their option. Now, the Chatham and Rochester Company being a small one with very heavy expenses, the promoters of the provisional order felt that the 21 years' limitation if insisted upon by the Chatham Board might destroy the prospects of the company, which at present supplies the light cheaper than any other company in England, though by the Board of Trade regulations they were permitted to charge 8d. a unit. Mr. Norman points out that the shares are all held locally with the exception of about 100 pounds' worth held by the South-Eastern Railway Company. The consent of the Board to the provisional order is absolutely necessary before the Board of Trade will give its sanction, but by insisting on the 21 years' limitation, the same position as would have been the case under the Act of 1882 is a result. If the provisional order is obtained without the 21 years' limitation, the company will secure larger and more suitable premises, and will have a new plant put down, and will supply motive power if the demand should be made for it, but without the removal of the short-time limitation it is feared that the company will have a difficulty in obtaining the requisite c



Front Elevation—Brush Engine, Bath.

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SHIP LIGHTING.

Last month the secretary of Lloyd's issued a circular to obtain information connected with the electric lighting of ships. It is stated upon very good authority that fires on board ship are more frequent since the introduction of the electric light, and that almost every case can be traced directly to bad workmanship. There seems to be little hope of reformation as regards bad workmanship till some one has pluck enough to face the dangers of a libel suit and publish a black list. If it were any other industry the controllers of the technical journals might feel that taking the bull by the horns would be followed by the sympathy and the support of the profession ; but with certain brilliant exceptions the members of the electrical industry seem more inclined to cut each others throats than to work in common, or to act so that cutting prices below what permits of good work should be impossible. Bad workmanship is due mainly to two causes : the ignorance of buyers as to the cost of good work and good materials, and the tendering for the mere purpose of getting the order, and at a price absolutely prohibitive of good materials or good work. Business men who desire to make fair, but not exorbitant, profits, whose desire is to develop a good sterling trade, and not to do work at the expense of their creditors, cannot possibly make great differences in tenders for the same work. They can buy their raw materials at about the same prices ; the wage bill is a pretty constant quantity throughout the kingdom. One may desire a five or a ten, or even a twenty, per cent. more profit than the other, yet only in exceptional circumstances should we expect to find the amounts of the tenders varying so that the highest was from three to four times that of the lowest. This, however, is by no means an uncommon thing, and means that numbers of tenders are not made up on business principles, but wilfully or ignorantly incorrectly. The damning character of the work put into ships may be gathered by the fact that Lloyd's has felt bound to issue this circular, the last sentence of which is peculiarly strong. The whole paragraph reads as follows, and we have italicised the words to which we specially call attention :

"I am directed, therefore, to address you on the subject, and to intimate that the committee will feel much obliged to you for any remarks and suggestions with which you may kindly favour them with regard both to methods of installation and also to the most satisfactory means of maintaining the insulation of wires and fittings unimpaired, so as to eliminate as far as practicable *the risk of fire which at present appears to attend the use of the electric light.*"

In season and out of season we have railed against the careless way in which some firms have done work ; and from the knowledge we possess, or believe we possess, have maintained that the electric light, properly installed, is the safest of all artificial illuminants either on shipboard or on land. Yet anyone reading a little between the lines of the paragraph we have quoted will see that the risk of fire has increased on board ship from the introduction of the electric light. It is admitted that fire, though a good servant, is a bad master, even on land; yet how much worse is it as a master on board ship?

It is extremely doubtful whether Lloyd's circular will lead to any suggestion that will effectually prevent the danger of fire, except it be to frame a code of rules which, if not followed, will prevent the ship being registered at Lloyd's. Collect and tabulate statistics upon every fire traceable to the electric light wires; state if possible the exact fault that led to the fire, and then ask, say, three experts to frame a code of rules to guard in future against such faults. The best way to be able to guard against faults is to know them.

The greatest possible attention should be paid to ship lighting, and every care taken to prevent doubts as to the safety of the light, for the industry owes much to this branch of business. The system of lighting is peculiarly applicable to ship work, and very large quantities of plant have been made and fitted for this purpose. It seems probable that every steamer and most sailing vessels will, in the long run, be fitted with all kinds of electrical apparatus, if only certainty and safety can be assured; but if the average rate of one fire per annum per ship fitted, which rumour gives as the present condition of things, continues, the demand will decrease instead of increase.

There is one point, however, which shows that while *some* electric light firms are willing to do bad work, the shipowners are just as much to blame in blindly following the mania for getting work done cheaply. We think that the circular of Lloyd's should bring out into bold relief the fact that ships built or owned by certain firms are not subject to the risks that other ships are subject to, from the very simple reason that neither the owners nor the shipbuilders are satisfied with the cheap and nasty. They willingly pay a fair price and take care to have good work and good materials. A little examination into the matter will show that a number of shipbuilders employ their own electricians, and in the cases where the electrician is a competent man the work is satisfactorily performed, though there may be found a few men employed to look after electrical matters whom it would be an honour to dub suitable candidates for the class Prof. Perry so admirably named "electric plumbers." It must then, we fear, be admitted that faults exist on both sides, and it is difficult to see how to overcome the trouble except in the manner we suggest—a series of stringent rules to be followed by contractors, just as the Phœnix rules have to be followed on land. The statement is made that where these rules have been followed no fire has occurred, and if that is so, the value of such rules cannot be over-estimated.

PRICE PER UNIT.

The discussion of the Eastbourne Town Council upon the letter from the Board of Trade, as to the price which may be charged per unit for electrical energy, will call attention to a phase of affairs which is by no means well understood. Here we have a company which has existed for some years, whose experience is somewhat unique, stating that it cannot profitably supply unit energy for 8d. per Board of Trade unit, and desirous of putting the maximum price in the provisional order at 1s. per unit. The Board of Trade justly says the price can be anything the buyers please to pay. There is no objection to put the maximum at 1s. or any other sum provided the buyers will admit that the circumstances of the case are more or less unusual and warrant the increase asked for. The company says the circumstances are not quite regular. The demand is not great, is not general, not concentrated, and thus the expenses of installing over a large area for a scattered *clientèle* are larger than would ordinarily be the case—hence a higher price may justly be demanded and paid. The Town Council decided to oppose the increase. Why, we cannot clearly make out. The majority who voted seemed to think that the electric light would, like the rippling brook, go on for ever, whether the company paid a dividend or not. All the provisional orders in the world cannot control the price of a commodity which one person has to sell and another wants to buy. The provisional order may say the maximum price per unit is to be 8d., or 10d., or 1s., or nothing, but what is the value of it? If the suppliers can't supply at 8d. and can supply at 1s., and if the users will buy at 1s., who is to prevent them? No Act of Parliament can do so, and thus we fail to understand the action at Eastbourne. We have elsewhere given a pretty full report of the discussion upon the subject, the moral of which seems to point to supply companies starting with a high price as the maximum, educating the purchasers, however, to the fact that the real price depends not on the amount stated in the order, but upon the lines which in ordinary business decide prices.

CORRESPONDENCE.

CHELMSFORD.

To the Editor of the Electrical Engineer.

Sir,—A paragraph has recently appeared in the columns of the daily press as to the lighting of Chelmsford by electricity in which it is stated that this is "the first town in the country to be lighted throughout by electricity."

My directors would be obliged if you would allow me to correct this statement. The town of Weybridge in Surrey is lighted by us throughout by electricity, and as this installation was started on March 1, 1890, Weybridge can certainly claim precedence over Chelmsford.

Nearly the whole of Waterford has been lighted by us for nearly three years, and all the principal streets of Taunton (visited last week by an official deputation from the City of London) have been lighted on our Thomson-Houston system for more than three years.—Yours, etc.,

W. Martindale, secretary.

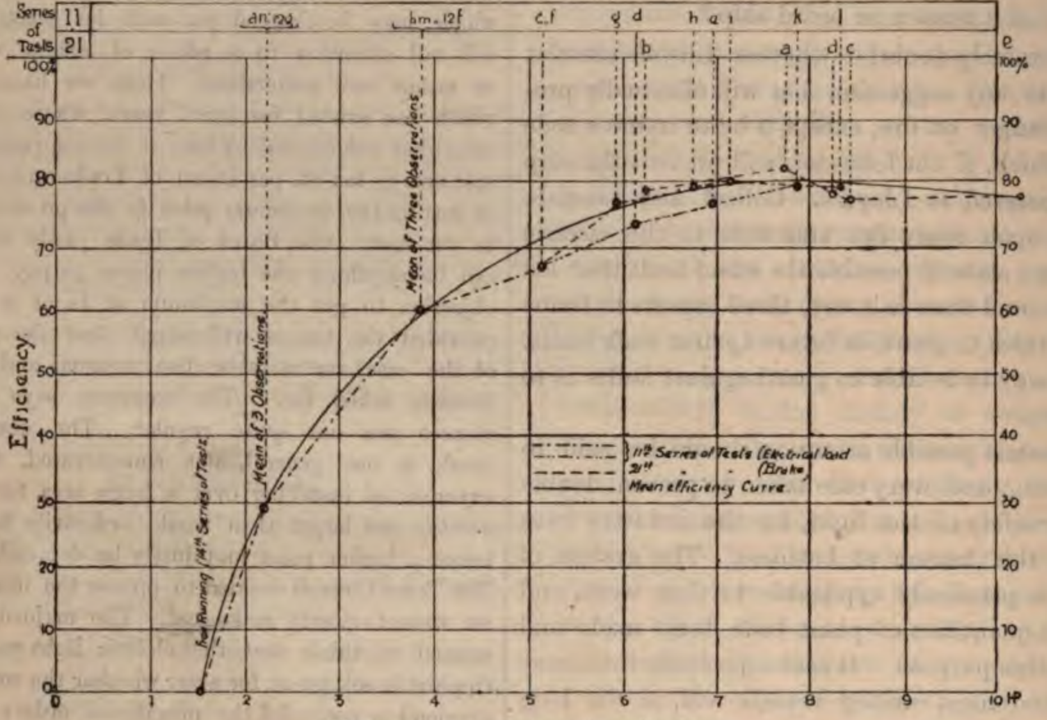
The Laing, Wharton, and Down Construction Syndicate,
82A, New Bond-street, W., April 18, 1890.

ELECTRIC LIGHTING PROJECTS IN FRANKFORT.

(Continued from page 313.)

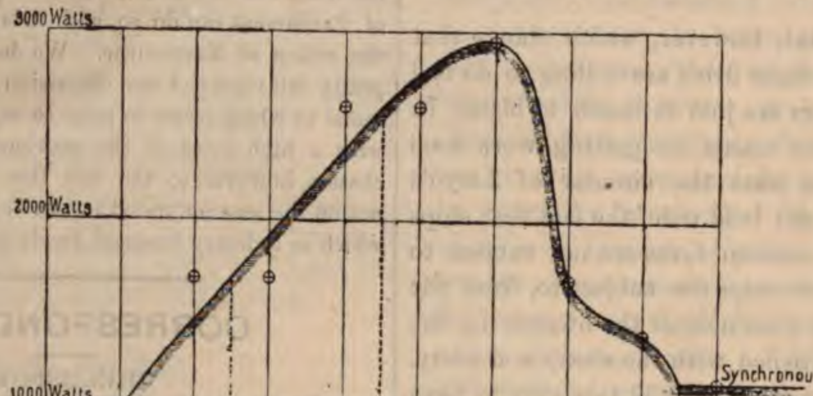
SERIES OF TESTS NO. 9.

Automatic Apparatus for Withdrawing and Inserting Alternating-Current Transformers.



Efficiency Curve. Series of Tests No. 11.

The automatic apparatus served five transformers, which energised the lamp battery of 200 32-c.p. lamps. It effected simultaneously the inserting and withdrawing of the high-tension 2,000-volt current and the low-pressure 105-volt current. One transformer remained constantly inserted. On the lighting of the lamps the automatic apparatus switched the transformers in one after another, until all of them were in circuit. When the lamps were extinguished the apparatus switched the transformers out, until all but the one mentioned were out of circuit.



Synchronising Curve. Series of Tests No. 14.

For a definite number of transformers with a fixed limit of demand, the addition or withdrawal of one lamp (= 100 watts) was sufficient to cause the automatic apparatus to throw in or cut out of circuit one transformer. The working of the apparatus was completely safe, and was not accompanied by any sparking or "dancing" of the apparatus. Moreover, no flickering of the light was noticed on the fluctuation in the pressure at the moment when the change was made. The ultimate results were that the automatic inserting and withdrawing apparatus worked in an admirable manner without the production of sparks, and that it would answer all practical requirements.

SERIES OF TESTS NOS. 11 AND 12.

These tests were made under varying conditions with a 5 h.p. Ganz alternating-current motor, worked through transformers by a 100 to 105 volt converted low-pressure current. The motor was of the four-pole type, and ran at 1,235 revolutions when the alternations of the primary machine were 4,940 per minute. It was provided with an automatic friction coupling, which, as soon as the load exceeded the permissible limits, became loose, so that the motor could continue to run, but without being synchronous with the primary machine. The motor was loaded with a Helios dynamo, and the recovered energy was measured in a similar manner to that adopted in previous tests. The following are a few of the results:

In test 11c the mean of three runs showed that the energy put in the motor was 3,785 watts, or 5·15 h.p. Then, according to the report, out of 5·15 h.p. put in the motor, 3·4 h.p. were recovered, showing an electrical efficiency of 66 per cent. The next series gave an efficiency of 73 per cent. The highest efficiency obtained was 79 per cent., and the average of 27 tests gave 74½ per cent. In the twelfth series of tests the load was suddenly thrown on and increased. In test No. 12a, an electrical efficiency was obtained of 72 per cent. The next test gave an electrical efficiency of 80 per cent., this being the highest efficiency obtained. The accompanying diagram represents graphically the efficiency of this motor.

SERIES OF TESTS NO. 13.

These tests were made with a ⅕ h.p. Ganz alternating-current motor in order to determine the production of sparks and also to ascertain what effect the arrangement of the brushes had upon the automatic running The production of sparks was very insignificant.

SERIES OF TESTS NO. 14.

In these tests with the 5 h.p. Ganz alternate motor it was found that this motor in certain positions also ran by itself about one-fifth of a revolution. The resistance on the wattmeter was 1,350 ohms, and one degree corresponded to 0·0267 × 1,350 = 36 watts. The following table shows the number of seconds necessary before the motor became synchronous with the primary machine :

Time in seconds.	Wattmeter.		Watts.
	Reading degree.	Corrected degree	
			unsynchronous run
0	−2	0	0
5	25	27	970
10	45	47	1,690
15	45	47	1,690
20	70	72	2,600
25	70	72	2,600
30	80	82	2,950
35	45	47	1,690
40	37	39	1,400
At this second the synchronous run commenced, and after that the change to normal exciting. Further running gave :			synchronous run.
	30	32	1,150

In the accompanying curve is represented the course of the motor until it ran normally.

SERIES OF TESTS NO. 15.

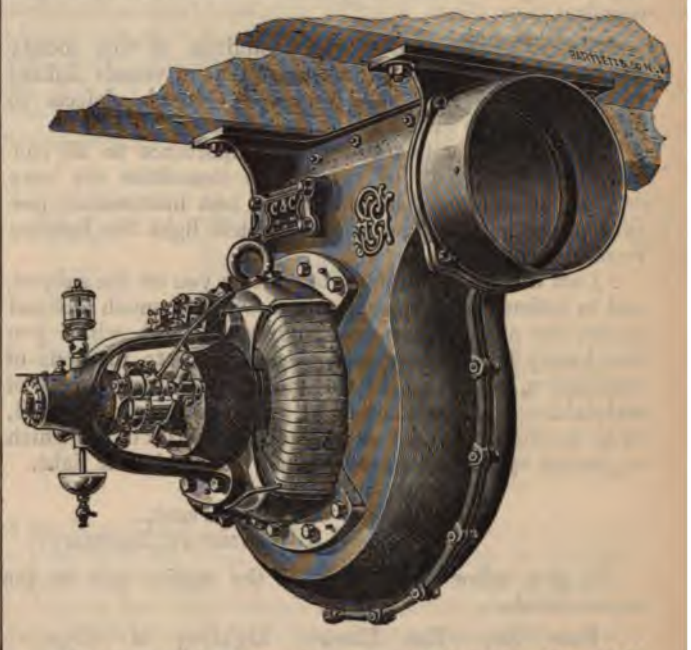
The commissioners conducted these tests partly in order to ascertain the applicability of motors to street railway working, and partly to determine the power required to start a car, and also that required on curves and inclines. The trials were made on the Frankfort-Offenbach electric railway with a car placed at the disposal of the commissioners by the manager. The current was led to the motor by an overhead conductor. The readings on the volt and ammeter were taken every five seconds. The motor and car when empty weighed four tons, and the extra empty car used in some of the tests weighed two tons. On the starting of the car the consumption of current rose to about 80 to 100 amperes. This quickly fell, and after five seconds amounted to 50 to 60 amperes, and after 10 seconds to 30 to 40 amperes. Then, on the car assuming its normal course, the energy required was 15 to 25 amperes, the mean pressure throughout being 280 volts. Thus the quantity of current required on starting the car was from five to six times greater than the normal amount. On an incline of one in 35 the energy consumed rose to 55 to 60 amperes, but on passing round curves no increase in the consumption took place, as on entering the curve the quantity of current was reduced in order to diminish the speed.

Rivals.—The Commercial Gas Company held its half-yearly meeting of shareholders on the 3rd inst., when dividends of 13¾ per cent. and 10¾ per cent. per annum were declared. The chairman in his report said they had absolutely nothing to fear from electricity ; their most potent enemy was cheap oil.

THE C. & C. MOTOR BLOWERS.

Within the last few years provision for proper ventilation has become a requirement in the designing and constructing of public and private buildings. The walls are traversed by air shafts and flues so that the kitchens, boiler-rooms, and the parts of the building where but a few years ago the discomfort of heat and bad air was looked upon as an unavoidable fact and accepted as such, are now rendered habitable and cool by the employment of exhaust fans and blowers.

Ventilation as applied to ships has been more carefully studied than in any other of its forms. The galleys, passage ways, boiler-rooms, and other portions of the ships constantly occupied by the crews, are especially in need of good ventilation, but they are often placed in parts of the vessel least accessible to the shafting and belting from the engines, so that in many cases it is impossible to use ventilating fans because of the difficulty of transmitting the power to drive them. A great many ships, especially in the passenger service and almost all men-of-war, are lighted throughout by electricity. This provides the means of attaining a proper system of ventilation and one that can be applied with equal ease to any part of a vessel. An electric blower can be put anywhere, as the wire carrying to it the current which furnishes the motive power can be introduced into one place as easily as into another, and this application of the electric current provides at once a most convenient and in some cases the only means of thoroughly renovating and purifying the air. The orifice of discharge in a blower is smaller in proportion to the amount of air passing through than that of any other machine for creating a forced draught of air, and this specially recommends it for ships and in places where the discharged current of air has to be carried a distance in pipes, as the pipes required are small and no special provision need be made beforehand to allow space for them. Any blower such as would be ordinarily required for this purpose would be small and not obtrusive to the eye, and hung on the ceiling it would be out of the way. By a small pipe the discharged air could be carried to the deck or any convenient point without taking room that might be needed for other purposes.



A No. 0 blower would take about as much current as is used by four incandescent lamps, while even a No. 7 blower will discharge 4,840 cubic feet of air per minute on the current of 40 lamps.

The illustration is made from the photograph of one of the C. & C. motors and blowers placed on the U.S. cruiser "Baltimore." It is type No. 4 and discharges 1,425 cubic feet of air per minute. Fastened to the ceiling of the dynamo-room it completely changes the air of the room once every two minutes, discharging it at a distant point through a small pipe. The machine is so compact that it takes up no space that could be used for anything else, and does its work so noiselessly that a person standing near cannot tell without the closest observation whether it is running or not.

The ease with which these blowers can be set up and connected to the dynamos, without requiring any shafting, belting, or other contrivance except the small wire, has already brought them to the attention of ship builders. For exhaust ventilation electric blowers cannot be surpassed.

The following table gives necessary information relating to this combination :

Type number.	Speed per minute.	Cubic feet of air per minute.	Height in inches.	Diameter inlet in inches.	Diameter outlet in inches.
0	2,000	450	18	5¾	4¼
1	1,900	635	20	6½	5¾
2	1,700	900	24	7½	7½
3	1,300	1,150	27	9	9
4	1,150	1,425	33	10½	10½
5	1,040	2,340	40	12	12
6	975	3,375	45	14	14
7	875	4,840	50	16	16

SHIP LIGHTING.

The following circular has been addressed by the Secretary of Lloyd's to those interested in the electric lighting of vessels :

"Sir,—The attention of the committee of this society has been drawn to the circumstance that in vessels lighted with electricity fires have occurred through defects in fittings, or in the insulation of the wires.

"As such accidents are of great importance to all concerned in the safety of vessels, the committee are very desirous of obtaining the fullest and best information possible respecting the use of the electric light for lighting vessels.

"I am directed, therefore, to address you on the subject, and to intimate that the committee will feel much obliged to you for any remarks and suggestions with which you may kindly favour them with regard both to methods of installation, and also to the most satisfactory means of maintaining the insulation of wires and fittings unimpaired, so as to eliminate as far as practicable the risk of fire which at present appears to attend the use of the electric light.

"I am, Sir,
"Your obedient servant,
"B. WAYMOUTH, Secretary."

We give below a specimen of the replies sent to the above circular :

"Dear Sir,—The Electric Lighting of Ships.—The subject of the circular has great interest for us, as also for probably most other London electric lighting companies.

"In our opinion, the chief cause of the fires you refer to is the exceedingly bad work that is, as a rule, put into ships' installations, and the bad quality of the wires used for conveying the current over the vessels. For a long time past the London firms interested in this class of work have almost ceased to tender for ship work, owing to the absurdly low prices paid for it, and which would not, were the work of a proper character, in many cases pay for the value of the materials used, without any consideration of the amount to be spent in the work of installing ; these firms being used, owing to the strict regulations insisted on by the various insurance companies, to executing work of a very high character alone, and knowing as they do from experience that safety with electric lighting can only be obtained when the work is thus excellent, they do not care to associate themselves with work of a character that will lead to accidents and thus injure their reputation. The wisdom of the regulations of these fire insurance companies is amply proved by the absolute immunity from accidents that has been enjoyed by those using electric light on land when their installations have been carried out under the supervision of these companies. It must not be forgotten in this connection that the currents used for the distribution of electricity from central stations on land are of a much more dangerous character than those used for ship lighting, and that therefore the accidents on land should be greater in number than on the sea, the other conditions being equal.

"Unhappily, the builders and owners of ships are quite ignorant, as a rule, of the classes of electrical work, and almost invariably accept the lowest tender, with the result mentioned in your circular. As an example of this, the writer, when on a voyage to the States on the "Umbria," one of the finest Atlantic liners afloat, witnessed a small fire caused by the electric lighting. We can safely say that work of the kind on this steamer would not be carried out by a third-rate firm in London ; it was as bad as could be.

"Another source of accidents on board ship is the use of the hull of the ship as a return wire. This at once halves the security of the installation, as if one branch of the other wire comes into contact with the hull of the ship an accident at once occurs, whereas had two wires been used the first contact would make no difference. The most stringent rule enforced in land installations is that the earth should form no part of the circuit, and it is difficult to know why this rule, if it is important on land, should not be thought so on ships, where, owing to the continual presence of damp, the chances of a short circuit are so much increased.

"In our opinion, the proper course to pursue to place sea installations on the same footing as land installations, and thus making them as safe, is :

"1. To insist on the work and the material being of the best possible character. To ensure this a system of inspection, like that of the fire insurance companies, should be instituted under a properly-qualified head, and vessels should be required to be certificated before acceptance as safe.

"2. The 'single-wire' system of installing the electric light should be absolutely abolished, and a double-wire system without any 'earth connection' be insisted on in all cases.

"If we can give you any further information on the subject we shall be happy so to do."

PHENOMENA OF ALTERNATING CURRENT INDUCTION.*

BY PROF. ELIHU THOMSON.

About three years ago I had the pleasure of bringing to the attention of the American Institute of Electrical Engineers at its annual meeting, certain phenomena of the repulsive action between conductors such as coils of wire traversed by alternating electric currents. It was then noted that if such a current be sent through a circuit wound as a coil, and either provided with an iron core, or not so provided, and permitted to induce in another coil or circuit a current under conditions which allowed a lag or displacement of phase of the latter from its theoretical position, a repulsive effort would be exerted, tending to remove one coil from proximity with the other, or to deflect one of them to a position such that the plane of the coils would be at right angles one to the other.

Many modifications of the arrangements of the coils were described and apparatus based upon the principle of inductive repulsion, as I called it, were touched upon. I need not now enlarge upon these matters. It may suffice to say that current indicators and potential indicators or voltmeters have been constructed embodying the principle as applied to the quantitative measurement of alternating currents. Arc lamps have been made in which the regulation of the carbons has been effected by the repulsive action of a coil traversed by the current fed to the lamp, or by a derived current around the arc, acting on a closed band or circuit movable with the regulating and feeding frame of the lamp. Various forms of alternating-current motors have been made in which the revolving portion is composed of coils arranged to be closed upon themselves, and inductively acted upon by the currents in what may be called the field or inducing coils connected with the alternating current source. The principle has been applied in other apparatus, such as regulating mechanism for alternating currents and in electric meters.

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* Abstract of a lecture delivered before the American Institute of Electrical Engineers at Columbia College, April 2, 1890.

It is my purpose this evening to bring before the institute some experimental apparatus showing the action of inductive repulsion in some of its phases, following this by a brief account of a number of other effects somewhat allied to it, with experimental demonstrations of the same. Some of these experiments were to be seen at the Paris Exposition of last year in connection with my exhibit there, and others of them are more recent still, while still others have never been shown at all in public. The field is a fruitful one, and there is not time to touch upon other than the more striking and perhaps interesting phases of the actions exhibited, which are susceptible of modification to a great extent by changes in proportion and arrangement of apparatus.

I may here revert to one experiment, which is almost a repetition of one I made about five years ago. If a copper disc or closed coil be balanced in front of another coil and parallel thereto, it will be noticed that on passing a current into the second coil the disc or closed coil will be repelled slightly, and if the current be afterwards shunted or cut off there will be a slight attraction. By opening and closing the shunt so as to put the current successively on and off the coil, there will be alternate repulsions and attractions exhibited. Let the current, however, be so put on and off very quickly, and the attractive effect will become less than the repulsive effect, and the disc or closed coil will be driven away or bodily repelled. Replace, now, the intermittent current by an alternating current, which reverses many times per second, and the repulsive effect alone is noticed, provided that the disc or closed coil is of sufficient mass and conductivity to allow currents of high self-induction to be set up in it, whereby such disc or coil or current in it may, as it were, exert a controlling influence upon the magnetic field in immediate proximity to it.

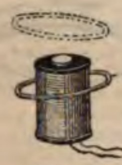


FIG. 1.

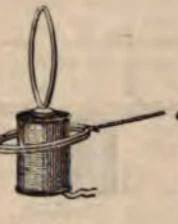


FIG. 2.

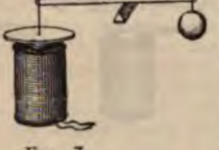


FIG. 3.

The amount of this repulsive effect may, under favourable circumstances, become so great as to give with moderate-current densities a very considerable pressure or force.

I have selected some particular instances of this action for our experiments, as it will be understood that time is too short to show many variations of the effect as found in numerous experimental trials.

Placing a copper ring over a coil which has been wound upon an iron core, and passing an alternating current through the coil, gives so much repulsive effect that the ring is thrown forcibly away and up into the air (Fig. 1). Or, again, the ring may be supported for a moment in free air, though its condition is one of unstable equilibrium. Further, we may arrange a string or thread to so guide the ring that it cannot move laterally though free to fall towards the alternating-current coil (Fig. 2). It is in this case supported in the magnetic field of the coil and away from it. It takes a position of balance between the repulsive effect and its own weight, which are opposed forces. As a curious variation, another copper ring (Fig. 2) may be added under the former, to which it seems to be attracted as though magnetised, after which both rings are supported as one. The explanation is very simple. The currents induced in both rings are in the same direction at any instant and produce attraction. The bearing of this will be seen in later experiments where rotary actions are produced.

Copper plates are but imperfect discs and act as closed coils. Aluminium rings, having much less weight than copper, might at first be expected to be more readily supported, but it must be remembered that the conductivity of aluminium is much less than that of copper, and hence that since the effect depends on current induced and retardation of phase or lag of such current, copper is the better on account of its high conductivity.

By attaching the closed ring or coil to a balance beam (Fig. 3), we are able to measure the amount of force exerted with different currents, and the different materials or constructions.

Such measurements show very decidedly that the repulsive effort depends on the strength of the current in the inducing coil, and in the ring or closed coil, and on the relation of the position of the waves of induced current in the closed coil or ring with those of the inducing coil. The effects are, properly considered, magnetic repulsive effects of the opposing fields of the induced and inducing currents relatively.

When the closed coil or disc is mounted so that it can only turn on an axis in its plane then the repulsion resolves itself into a deflection of its plane to a position at right angles to the plane of the inducing coil, or, more strictly, to parallelism with the direction of the magnetic lines set up by such inducing coil. The effect of the control exhibited by such a closed circuit of good conducting power over the magnetic field of the inducing coil, is seen by interposing such closed circuits between the inducing coil and another coil acting as a secondary and feeding an incandescent lamp (Fig. 4). The light of the lamp is cut down and extinguished thereby, as the alternating field is now almost completely shielded from the secondary. The coil feeding the lamp undergoes a slight repulsion. This is easily exhibited by placing in a glass jar with water a lamp and coil, the lamp wires being connected with the coil terminals, and so loading it that it just sinks to the bottom of the jar. Placing this above the inducing coil so as to bring it into the alternating magnetic field is attended not only with the lighting of the lamp under water, but there is noticed a repulsion or floating of the lamp to a certain point (Fig. 5), at which its tendency to sink just balances the repulsion exerted. So long as the lamp remains so suspended in the water its brilliancy is constant, notwithstanding that the strength of the inducing current be raised or lowered considerably. It is, of course, unnecessary to use water to balance the lamp coil; a beam and counterpoise weight will suffice (Fig. 5a).

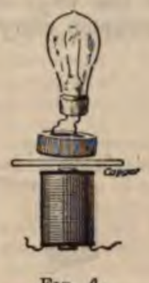


FIG. 4.

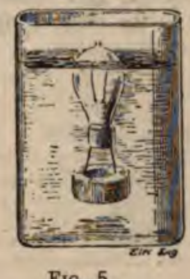


FIG. 5.

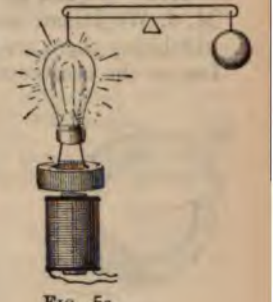


FIG. 5a.

In utilising the repulsive action for obtaining movement from alternating currents, the closed coil or circuit may be mounted in various ways.

A convenient form is one in which a bent core of iron wire or plates which may be a ring is wound over with insulated wire at a portion only of its surface. A closed band or secondary is pivotally mounted, so as to pass over the curved core, and also over the wire-covered portion if moved around the pivot by a suitable carrier (Fig. 6). A spring or weight may tend to cause the closed band to pass over the wire-covered portion of the core. Currents sent in the wire coil produce repulsion and movement of the closed band about the pivots to a position on the core removed from the coil.

This apparatus, and some of its modifications, is a valuable reactive coil, which gives a smooth variation, and hence is called a "smoothly-acting reactive coil," for it enables us by changing the relation of the closed band or secondary circuit to affect the inductive resistance, as it may be termed, or the impedance of the coil wound on the core, the changes being made by swinging the closed band on its pivotal support by a suitable operating handle. It so varies the effects in an alternating circuit as to represent those of variable resistance in a continuous-current circuit, but it does this without much loss of energy, and not by steps, but through the finest gradations. The power is greatly increased by the provision of a movable iron armature for the core, centrally placed and pivoted, carrying the closed secondary coil upon it.

It is easy to see that by placing on a laminated armature core a series of coils which can be suitably short-circuited by a commutator, and placing such armatures between poles of alternating magnetic polarity, or, better, surrounding such armature by coils for producing directly in it an alternation of magnetic states, while the magnetic circuit is completed by an outside magnetic circuit of laminated iron, we have obtained a rotary motor for alternating currents which may be termed a transformer-motor, since the armature currents are induced and not obtained from the outside.

But by properly constructing such a machine, it is not necessary to have a commutator if we are content to start the motor initially by some means, for we may close the armature coils on themselves, pass alternating current through the field coils so as to establish an alternating field in which the armature exists, and it will be found that the machine will turn in the direction in which it has been started and run up to a speed depending on the construction. I have constructed a number of such machines, some of which are self-starting without a commutator. They are made self-starting by special features of construction. Whether they can be made of high or fair efficiency remains to be seen. Using only one alternating current they can, of course, be used on existing lines.

There are a number of curious effects to be described which depend on a shifting or propagation of magnetic lines of force.

Many of these effects were worked out conjointly by Mr. M. J. Wightman and myself, and some of the ways of exhibiting them are due to the skill of my workmen carrying on the construction of apparatus.

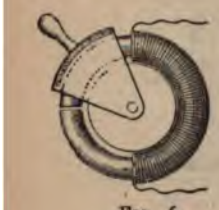


FIG. 6.

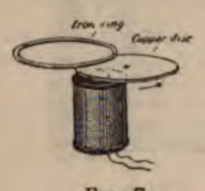


FIG. 7.

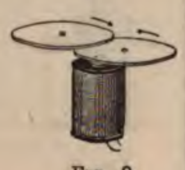


FIG. 8.

The principles may be briefly stated as follows:

1. If two or more closed circuits are similarly affected inductively by an alternating magnetic field, they will attract one another and tend to move into parallelism.

2. Iron or steel masses placed in an alternating magnetic field give rise to shifting magnetism, or lines of force moving laterally, and may, therefore, act to move closed circuits in the path of such shifting lines.

3. Closed circuits in alternating magnetic fields, or fields of varying intensity, give rise to shifting magnetism or lines of force moving laterally to their direction, and may, therefore, act to move other closed circuits in the path of such lines.

4. Iron or steel masses may, when placed in an alternating magnetic field, interact with other such masses, or with closed electric circuits, so as to produce movement of such masses or circuits relatively, or give rise to tendencies to so move, the effects depending on continual adaptations of shifting magnetism and retained magnetism relatively.

The experimental demonstration of these principles can be carried out with very simple apparatus. The explanations of the actions which occur in accordance with known principles are in many cases very evident, and in others are arrived at with a little study. Nevertheless, the experiments illustrate, in a marked manner, properties of matter and peculiarities of magnetic action which will probably never be fully understood unless the nature of the ether and its relations to what we call matter are discovered.

We will return to the case of the ring attracting another ring to it. Here we have the case of like currents in parallel direction producing attraction. Such an action can be made continuous. We have only to place a ring or plate over the alternating-current coil or pole of its core and then bring a copper disc free to revolve on pivots into proper position relatively thereto. This can best be done by placing the ring or plate so as to be somewhat to one side of the pole, so as to shade it in part, as it were, while a part of the pivoted disc is placed under it, or over it, in front of the alternating field pole (Fig. 7). The disc then revolves from the unshaded portion of the pole towards the shaded portion where the closed ring or plate is placed.

The actions are due to lines of magnetic force at each alternation of current in the magnetising coil below meeting a retarding influence or opposition to their development over that part of the pole shaded by the copper ring or plate owing to currents induced therein. The copper disc is the seat of similar currents, but chiefly about those portions not shaded by the ring or plate. Owing to self-induction, these currents in ring and plate tend to persist into the period of reversal of the field. This gives rise to a movement of those portions of the disc where current is flowing into a position directly adjacent to the ring or the currents flowing in it, an action which is repeated at every alternation and results in a revolution of the disc. While this explanation is probably the simplest it must be borne in mind that it is but an expression of a set of magnetic actions or changes in the magnetic field; such magnetic field being the resultant of the changing force of the original alternating inducing field and of the magnetic effects of the currents set up in a ring or plate and the disc, both of which latter have a retarding action due to self-induction of the currents in them.

If, now, two discs be used instead of one (Fig. 8), it will be found that they may each shade a portion of the pole, and that the discs, if made to overlap, will both revolve in opposite directions relatively.

An iron disc may be substituted for one of the discs above and used with the fixed plate or ring below it, and so be caused to revolve, and its position can be changed so that it is in a plane vertical to the plane of the plate or ring (Fig. 9). Also, it may be similarly used in relation to the revolving copper disc. In fact, the positions of two copper discs pivoted so as to be revolvable, or of a copper and iron disc, may be greatly varied and effects of rotation obtained.

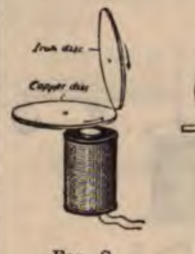


FIG. 9.

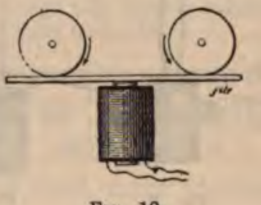


FIG. 10.

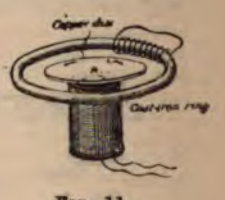


FIG. 11.

If we vary the experiment by placing a closed coil around a part of an iron core upon which is also wound a coil which can be put into an alternating-current circuit the effects obtainable are similar to those described above—that is, the structure becomes capable of revolving copper or iron discs held near it. The direction of revolution is such as to indicate a propagation of magnetism or magnetic polarity at a retarded rate through that portion of the iron core covered by the closed coil. In this respect a bar of iron unlaminated, or not divided, is the same as a core surrounded by a closed coil, for it is also capable of causing the rotation of the discs, when such a bar is abutted to a laminated core alternatively magnetised, or when such a bar is surrounded at part of its length only by the magnetising coil. A bar of steel substituted for the iron, even if well laminated, is able to cause brisk rotations of the copper or iron discs.

With hardened steel the action is the more marked, a file serving for the experiment. Here the "hysteresis," or coercive force, or magnetic friction retards the propagation of the magnetic wave. By laying a large file flatwise against the alternating magnet pole at about the middle of the file (Fig. 10) two discs of copper or iron may be kept revolving, or one each of copper and iron held over those portions of the file projecting from the pole of the magnet over which it is laid will revolve. The iron disc may be held vertically, and the copper horizontally or flatwise to the file.

Cast iron behaves like steel, though more feebly. A ring of cast iron, having a closed coil wound on one part (Fig. 11), can be laid on the pole of the alternating magnet coil, and it will rotate an iron disc concentric with it if the placing of the closed coil portion of the ring is not made so as to bring it either over the pole or diametrically opposite that point, the best effect being obtained when it is alongside of the pole.

(To be continued.)

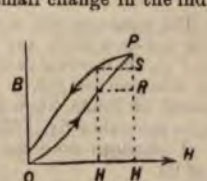
PHYSICAL SOCIETY.—April 18.

Prof. W. E. AYRTON, F.R.S., President, in the chair.

Mr. W. B. Croft was elected a member of the society.

Prof. Rucker described the results of "**Some Recent Magnetic Work**" undertaken by himself and Prof. Thorpe in connection with their magnetic survey of the United Kingdom. In a paper read before the Royal Society last year they have shown that the United Kingdom can be divided into seven or eight distinct districts, in each of which a source of disturbance seems to exist. The probable cause of these disturbances the authors believe to be the presence of "magnetic rocks." If this be true, an intimate connection should exist between the magnetic elements of a district and its geological structure. If a magnetic mass be supposed to exist below the surface, then one would expect the vertical force to be greatest above that mass, whilst the horizontal disturbances would tend towards the mass, and would differ in direction on its opposite sides. With a view to testing more fully than heretofore the magnetic constitution of the districts above referred to the work (the results of which Prof. Rucker now described, was undertaken. Two test districts were selected in which numerous observations were taken; one of these is situated on the west coast of Scotland, and the other embraces parts of Lincolnshire and Yorkshire. The first of these districts was chosen for two reasons: First, because it is very disturbed, and owing to the vast masses of basalt would be a specially difficult one, and, secondly, because it is near the borders of their survey, and is thus particularly open to suspicion that the calculated values of the elements may be inaccurate. By the aid of magnetic maps Prof. Rücker showed that a centre of disturbance exists to the west of Iona and south of Barra. Both the vertical force and the horizontal disturbances indicate the same position, and hence favour the hypothesis. In the Lincolnshire and Yorkshire district, extending from The Wash to Appleby, there is a region in which the horizontal disturbances along the east side tend towards the west, whilst along the west side they are on the whole directed easterly. This points to a ridge of magnetic material along the middle of the region, and from numerous observations the approximate position of the ridge line has been determined over a length of 150 miles. In Lincolnshire the ridge follows closely the line of Wolds, whilst at the Kettlewell end it is directed towards the Cumberland lake district. Places of maximum vertical force occur near Market Weighton and Harrogate. The observers were directed to Market Weighton by Prof. Judd, as being situated where the liassic strata thins out. Harrogate stands on the summit of an anticlinal. The fact that such places of maximum vertical force exist where, according to hypothesis, they would be expected, tends to confirm the supposition, and thus to demonstrate that a very close connection exists between the magnetic elements and the geological structure of a country. This is further confirmed by the observation that in Lincolnshire the line of disturbance follows closely the line of the Wolds, and that from Market Weighton it passes across the plain of York to the millstone grit and limestone, which are the oldest rocks in the neighbourhood. **Mr. Whipple** said he had listened with very great pleasure to the most interesting details and results given by Prof. Rücker. Never to his knowledge had a magnetic survey been conducted with such minuteness and accuracy. The older surveys related chiefly to declination, whilst the determinations of intensity were made in a very primitive way. He looked forward with great interest for other important results which he felt sure would follow from the admirable survey of Profs. Rücker and Thorpe. A most cordial vote of thanks was accorded to Prof. Rücker for his most interesting and valuable communication.

Mr. T. H. Blakesley, hon. secretary, read a paper on "**A Theory of Permanent Magnetism,**" by M. OSMOND. The author stated that iron exists in two distinct physical states—one soft, or "*α iron*," and the other hard, or "*β iron*." The β variety is non-magnetic, and is formed during heating, hardening, or by electrolysis, whilst the soft or α modification is produced by long annealing. In a piece of steel the author considers the β molecules to form a rigid framework in which the α molecules become interlocked under the influence of magnetising force, and on the degree of interlocking the permanent magnetism depends. By a graphical method it is shown that the permanent magnetism should be a maximum when the two varieties are present in equal quantities. If the proportions of carbon and manganese in the steel are considerable, then nearly all the iron is of the β variety, and the steel is nearly non-magnetic. In hardening a piece of ordinary steel, the surface layers being cooled most rapidly contain more β molecules than the interior; hence for a certain degree of hardness (when the outer layers have more α molecules than β ones) a laminated magnet will be a better permanent magnet than a solid one, but for a much greater degree of hardness the reverse may be the case. **Mr. Swinburne** asked if the theory would account for the increase of induction which occurs when the circuit of a permanent magnet is closed. Most theories founded on the orientation of particles by the magnetising force seemed defective in this respect. Some time ago he had suggested that the permeability of iron should be tested by first magnetising it one way, and then at right angles to the first direction; recently he had been informed that no increase of permeability was observed when the experiment was performed. **Prof. Perry** said he had subjected iron to magnetisation in one direction, and found the permeability for small forces in a direction at right angles much smaller than he had anticipated; the first magnetising force was kept constant when the small perpendicular one was applied. **Mr. Swinburne** thought that for such small perpendicular forces the permeability should be nearly infinite. He also said there seemed to be a sort of angular hysteresis in iron, for if a loose running armature was turned slowly round by hand it would come back two or three degrees when left free. The **President** remarked that as far as he could see M. Osmond's theory does not account for the great influence which a small percentage of tungsten has on the magnetic property of steel, and all theories which failed in this particular must necessarily be imperfect. **Mr. Blakesley** pointed out that the ordinary hysteresis curves showed that a small superimposed magnetising force, in a direction different from the primary one, produced only a small change in the induction, and hence would give a small permeability. For example, the increment, H^1 H, (see Figure) causes an increase, R P, in the induction, whilst an equal decrement, H^1 H, produces only a change, P.



EASTBOURNE.

THE ELECTRIC LIGHT QUESTION.

At the last meeting of the Town Council a matter important to most supply companies was discussed.

A letter was read from the Board of Trade forwarding copy of a letter received from the Eastbourne Electric Light Company's agents in support of the company's application for a provisional order, and pointing out that the maximum charge in the model form of order prepared by the Board of Trade was 8d. per unit. The Board stated they did not propose to allow a higher price unless special circumstances existed to justify it, and they asked for the observations of the Corporation at as early a date as possible.

The letter from the company's agents set forth various reasons why a charge of 10d. per unit should be sanctioned. The company had, it was stated, laid out between £25,000 and £30,000 in engine works, in the laying on of nine miles of mains, and other purposes incidental to the supplying of electricity in Eastbourne. The charge now made was 1s. per unit. At that price no profit had been made. The use of electricity would be confined to shops and the houses of wealthy residents, which were generally detached and therefore involved a large amount of "mainage." In asking for 10d. the company were acting on no speculative theory, but were thoroughly convinced that if a lower charge were insisted on it was impossible to put forth any prospect of obtaining a dividend, so as to induce capitalists to put money into the business. Attention was called to the fact that the Corporation of Eastbourne had assented to the application and to a charge of 10d. being included in the order, and a hope was expressed that the Board of Trade would allow that figure to stand, particularly as the local authority had power of appeal every seven years. The company claimed during the last eight years to have acted as the pioneers of electric lighting in England.

The **Mayor**: What will you do with this communication?

The **Deputy-Mayor** (who is chairman of the Electric Light Company): I may be allowed to say that 8d. is a sum at which the electric light could not be supplied. Therefore, if 8d. is fixed by the Board of Trade the Electric Light Company will be obliged to shut up their works and post up on the door, "No further supply."

Mr. Homewood: What, as a Corporation, have we do with the matter? We have the electric light on the parade, but as a Corporation this question of what the general charge should be does not seem to belong to us at all. It is for the public to say whether they will pay 8d., 10d., or 1s. when the charge is made.

The **Mayor**: There is a form to go through with regard to these provisional orders, and the Board of Trade have pointed out the condition on which they will sanction a higher price than appears in the model order.

Mr. Wallis: I would suggest that inasmuch as the Corporation have no experience as to the manufacture of electricity the answer should be given by the Electric Light Company. It seems to me an extraordinary piece of legislation on the part of the Board of Trade to issue an order of that character. I apprehend a number of provisional orders have been granted at much higher rates; and is it the intention of the Board of Trade to withdraw their sanction and require these companies to supply at an unremunerative price? We have heard from Mr. Boulton that the light cannot be manufactured at 8d. If the Corporation decide to give an answer, we should first obtain information of a practical character, based on experience, and that cannot be got better than by consulting the directors of the Electric Light Company.

The **Mayor**: Do you make a proposition to that effect?

Mr. Wallis: I only desire to proceed on lines that should have some degree of consistency. The Board of Trade may say "You shall only charge 4d." But they have no right to require a company to work at a loss. They may be well-informed, but if they want information as to particular cases they should obtain it from those who are mixed up with the concern. We, as a Council, are not in a position to give it them. As Mr. Homewood remarked, it is a matter for private residents and tradespeople either to take the light or let it alone, and as regards the Corporation it is simply a matter of lighting the parades or not. The members of the Council will light the parades as best suits the town. I feel also that if a decision is to be given it should not be given offhand.

The **Mayor**: They require, you see, an early reply. I should like to point out that the question they ask is a very simple one to answer. The maximum price in the model form of order is 8d. per unit, and they do not propose to allow a higher unless special circumstances exist in any particular case which would justify an increased price. It is for us to decide if there are any special circumstances in our case which would justify a price above that in the model form of order.

Mr. Homewood: What right have we to fix the price?

The **Mayor**: We are the people to say if any special circumstances exist.

The **Deputy-Mayor**: The company will not supply electricity at less than 10d. They could not do it with any chance of ever seeing a profit; and if 8d. is fixed we shall refuse to take the order, and shall go on charging, as before, what we can get.

Mr. Bennett: The Board of Trade know more about it than we do, and we should go by the price they fix. We must look after the outside public a little. I shall propose we accept the Board of Trade's recommendation of 8d.

The **Deputy-Mayor**: Then I may say we shall not accept the provisional order of the Board of Trade.

Mr. Wenham: I will second Mr. Bennett's motion. Notwithstanding what has fallen from Mr. Boulton, I do not doubt that electricity will go on. We shall not stand still; and I fail to see any reason whatever why Eastbourne should pay more for electricity than other towns. There seems to me no doubt the Board of Trade have based that price on good grounds, and I, for one, see no reason why we as a Council should recommend a higher price than that proposed by the Board of Trade.

Mr. Tomkinson: I think the letter from the company's agents to the Board of Trade gives some very good reasons why the price should exceed 8d. I do not wish to favour any particular party, but it must be admitted the electric light has been of great benefit to the town. In a small place like Eastbourne the electric light cannot be supplied on the same terms as in larger towns, and the company have stated that it is impossible to accept the price of the Board of Trade. That being the case, I think the Corporation ought to support the company in their efforts to obtain a fair price, so as to make the electric light remunerative.

The **Deputy-Mayor**: We have made no profit even at 10d.

The **Mayor**: You say the price should be higher; but you forget in this letter it is distinctly pointed out that the electric light is intended to be furnished to shops which have merchandise that may be damaged by gas, and to the houses of wealthy residents, which are chiefly detached. If, therefore, the company laid themselves out to supply the town at large, it would make Eastbourne a larger town than it is at present, so far as they are concerned, and they could do it at a cheaper price.

Mr. Tomkinson: They say they cannot supply it at a lower rate.

The **Mayor**: On account of the restricted supply which, according to their letter, is to extend only to shops and the houses of wealthy residents.

Mr. Martin: If the provisional order fixed the maximum at 8d., we might allow the company to charge a little more for a time, and might pin them down if we found they were making more than they ought to.

Mr. Crook: When we gave our sanction to the provisional order it was on the understanding the limit should not be fixed at 8d., and we should stultify ourselves now if we did not continue to support the demand of the company. I think the company show there are exceptional circumstances which would warrant an increased price per unit, and my own opinion is the Corporation should continue to support the company, as in the past.

The **Mayor**: It would be more like stultifying ourselves not to give the special reasons if they exist.

Mr. Crook: The letter of the company's agents gives the special reasons, and if the Corporation can see their way to endorse those they should do so.

The **Mayor**: Do you move an amendment?

Mr. Crook: As it would be a direct negative I thought that unnecessary.

The **Mayor**: The motion is "That an answer be sent stating that the Corporation see no reason to complain of the price proposed to be charged, as fixed by the Board of Trade in their model provisional order."

Mr. Towner: What are the Electric Light Company receiving now?

The **Deputy Mayor**: 1s. per unit up to a certain amount, and 8d. and 4d. afterwards. It is a sliding scale, and a system which has never been found to pay.

The vote was then attempted to be taken, but after the question "for" the motion had been put,

Mr. Towner asked whether members interested in either the Gas or Electric Light Companies were entitled to vote.

The **Mayor**: It is not my business to prevent them voting, but they do so at their own risk, and it is generally considered to be better they should not do so.

Mr. Bennett: Then I am out of order.

Mr. Mitchell: You are a gas man (laughter).

The **Mayor**: I cannot say Mr. Bennett is out of order. I can only say he voted at his own risk.

Mr. Mitchell: I rise to order. Can a proposition legally be accepted from Mr. Bennett, seeing he is a shareholder in the Gas Company?

Mr. Wenham: Perhaps the Town Clerk will enlighten us.

The **Mayor**: I was distinctly told last time I could not object to take it, but it was for parties interested to take action against any gentleman voting who had no legal authority so to do.

Mr. Bennett: I will withdraw my proposal of the motion.

Leave for such withdrawal having been given by the Council,

Mr. Wenham said he would move the motion standing in Mr. Bennett's name.

Mr. Ford seconded.

On a division eight voted for the motion and six against. For: The Mayor, Mr. J. Rudd, Mr. Mitchell, Mr. Martin, Mr. Pearce, Mr. Wenham, Mr. Ford, and Mr. Adams. Against: Mr. Wallis, Mr. Homewood, Mr. Pocock, Mr. Burt, Mr. Crook, and Mr. Hurst. The motion was therefore carried.

Mr. Keay: I rise to a point of order. The Council having passed a resolution in favour of the electric light provisional order, embodying the price suggested by the company, that cannot be rescinded without due notice. We have actually voted for that which a majority now seek to set aside.

The **Mayor**: I beg to submit I do not think we are at all out of order. We are answering a letter from the Board of Trade, who point out that 8d. is the maximum in their model form, and who ask us if there is any reason why the Electric Light Company of Eastbourne should charge more. We say, "No." We do not rescind any resolution we have carried previously.

Mr. Wallis: I submit, with all deference, it is absolutely setting aside the decision arrived at when the question of electricity was discussed. I do not think you have given the members a fair opportunity of acquainting themselves with the facts in the matter. Letters have been written to the Council bearing on the most important question of the electric light in this town, and we are told the life or death of it may depend on the answer; yet, without any time for reflection, an answer is at once given of a nature which is seriously prejudicial to the company. If the electric light is not to be continued in Eastbourne, I believe there will be a falling off in the prosperity of the town. These letters have been sent to the Council without any single member being aware of what was going to take place, and by precipitating it in this manner you have not given the members an opportunity of coming here and expressing their opinions.

The **Mayor**: I don't think it is exactly fair to say I have not done so.

Mr. Wallis: I don't mean you personally.

The **Mayor**: The letter is here and members of the Council have voted. Any objection to its being now considered should have been made when the letter was first read. As a matter of fact, the Council had to come to a decision to-day, because the Board of Trade ask for an immediate answer.

Mr. Wallis: They ask for an investigation and an expression of opinion.

Mr. Wenham: The letter does not mention the word "investigation."

Mr. Wallis: It conveys it by implication. It certainly asks us to express an opinion, and I should like people to think about things before they venture their opinion, otherwise the opinion cannot be said to be worth much.

The matter then dropped.

COMPANIES' MEETINGS.

EASTERN EXTENSION TELEGRAPH.

The thirty-third general meeting of the Eastern Extension, Australasian, and China Telegraph Company was held on Wednesday at Winchester House.

Sir John Pender, in moving the adoption of the report, stated that the gross receipts, including Government subsidies, had amounted to £264,103, against £238,854 for the corresponding half-year of 1888. The working expenses had amounted to £73,498, leaving a balance of £190,604, from which was deducted income tax, interest on debentures, and contributions to sinking funds. This left £144,758 as the net profit for the half-year, which, with £26,236 brought forward, showed an available balance of £170,994. It was satisfactory, he thought, that one quarterly interim dividend of 1¼ per cent. had been paid for the half-year, and it was now proposed by the Directors to distribute another of like amount, making, with the interim dividends paid for the first half-year, a total dividend of 5 per cent. It was also proposed to pay a bonus of 4s. a share, or 2 per cent., making a total distribution of 7 per cent. for the year. The balance of £58,494. 12s. 2d. had been carried to the reserve fund, which, after being credited with the interest on investments received during the half-year and a surplus profit resulting from a careful revaluation of the spare cable and stores in hand, and debited with £76,461 on account of the cost of the Western Australia cable, and further partial renewals of the Hong Kong-Saigon cable, now stood at £710,113. He referred to the subsidy agreement with the Government of the Straits Settlements in respect of the Malacca-Singapore-Penang cables, which expired in August, stating that a fresh arrangement had been entered into for a reduced subsidy of £400 per annum, payable for an additional five years. All their cables were in good working order, and as there had been considerable interruption in the communication between Sydney and New Zealand they had decided to duplicate that line. This cable was now being laid. In consequence of the frequent interruption of the Madras-Penang section in the neighbourhood of the Nicobar Islands they had also made a contract with the Telegraph Construction and Maintenance Company for the renewal of 650 nautical miles of the cable. Referring to the question of reduced tariff, he said that the idea that telegrams could be transmitted from England to Australia for 1s. per word was entirely erroneous. The distance to Port Darwin was nearly 12,000 miles, and their actual out-payment was 4s. 10d. per word before the Company received anything. Therefore he felt it his duty to show them that a tariff such as that suggested was impossible.

The motion was seconded by **Mr. F. A. Bevan**, and unanimously adopted.

REUTER'S TELEGRAM COMPANY.

The twenty-sixth ordinary general meeting of the shareholders of Reuter's Telegram Company, Limited, was held on Wednesday at the offices, 63, Old Jewry, Admiral the Right Hon. Sir John C. D. Hay, Bart., K.C.B., presiding.

The **Chairman**, in moving the adoption of the report (which recommended a dividend at the rate of 6½ per cent. per annum), congratulated the shareholders that on that, the twenty-fifth, anniversary meeting of the Company, the Directors had to present a favourable statement. At the last meeting they had rather poor results to show for the year 1888, owing to causes which were then indicated. The year 1889, though not devoid of important events entailing considerable expense, had been a comparatively quiet one for telegrams. There had been none of those little wars which drained their coffers without deriving extra contributions from their subscribers. The quieter state of political affairs had been accompanied by great prosperity in most countries, and the Company's revenue had in consequence been swollen by extra sources of income. In a business like theirs, it was always unwise to disclose their affairs too minutely for the advantage of active competitors whom they had to face in many quarters, and the Directors knew that the shareholders always appreciated their reticence. The Board must warn the shareholders that a check to trade meant a restriction of commercial telegrams and subscriptions, so that the favourable figures they now submitted must not be considered as outside the influence of trade fluctuations as well as political affairs. For this reason the Board had thought it prudent to replace two-thirds of the amount which was taken from the reserve fund to make up a 5 per cent. dividend in April last year. The reserve would then stand at nearly £12,000, so that their financial position was strong. With regard to the negotiations with their continental allies, he was happy to say that, thanks to their Managing Director, who made sundry trips abroad to personally conduct them on behalf of the Company, they had resulted in the conclusion of new agreements for a term of many years. Whilst they were thereby fortified against competition of an international character, they preserved their absolute independence in their own territories. The same independence was enjoyed by the different national agencies in their respective countries with which Reuter's was connected by working arrangements. In conclusion, the Chairman referred in terms of eulogistic regret to the retirement of the Secretary.

The **Hon. Mark Napier** seconded the adoption of the report, which was agreed to unanimously.

On the motion of the **Chairman**, seconded by **Mr. Herbert de Reuter**, the Hon. Mark Napier was re-elected director. Messrs. Welton, Jones, and Co., were re-elected auditors.

COMPANIES' REPORTS.

ORIENTAL TELEPHONE COMPANY, LIMITED.

Directors: William Addison, Esq. (chairman), B. St. John Ackers, Esq., Henry Grewing, Esq., Right Hon. G. A. F. Cavendish Bentinck, M.P., Thomas Lloyd, Esq., George Bland Frost, Esq. Secretary: Alexander B. Chalmers, Esq. Auditors: Messrs. Deloitte, Dever, Griffiths, and Co.

The report of the Directors for the year ending 31st December, 1889, to be presented at the tenth ordinary general meeting of the Company, to be held at the City Terminus Hotel, Cannon-street, on Tuesday, the 29th ult., states as follows:

The net profit for the year is £7,119. 1s. 11d., after writing off £438. 6s. 3d. for exceptional expenses at three of the Company's branches. Including the sum of £685. 18s. 11d. brought forward from 1888, the amount available for disposal is £7,805. 0s. 10d., which the Directors recommend should be dealt with as follows: To place £2,000 to the reserve fund; to transfer £500 in reduction of value of stores at branches; £340. 13s. in reduction of amount expended on exchanges on hand, which will then stand at £34,000; and to pay a dividend of 3 per cent., free of income tax, on the paid up capital of the Company, other than the vendors' shares, carrying forward £1,237 2s. 8d. The returns from the Indian Companies for the past year show an improvement. The Bengal and Bombay Companies have declared dividends of 4½ per cent. and 3 per cent. respectively on their issued capitals. The Telephone Company of Egypt has declared a dividend of 6 per cent. on its preferred shares, free of income tax, and carries forward £1,459. 1s. 4d. The dividends accruing on the shares held by this Company, in the above-named companies, have been brought into the accounts as usual. The exchanges at Rangoon and Singapore continue to expand, but those at Madras, Maulmain, Colombo, and Port Louis make but little progress. A change has recently been made in the management at Mauritius, involving some additional initial expense, which it is hoped may result in some improvement at that branch in the early future. The China and Japan Company has further developed its exchanges at Shanghai and Hongkong. The accounts for the past year shows a surplus of £573. 16s. 4d., after paying debenture interest and writing off £300. 15s. 10d. in respect of depreciation and preliminary expenses. In order to provide that company with more working capital, your Directors have taken up, during the current year, an additional £500 of its 7 per cent. debentures. During the early part of last year, a circular was issued by the Directors to each holder of the vendor's shares, asking them to meet the Board in reference to a rearrangement of capital account. A meeting was held in response to this circular, but up to the present the negotiations have not resulted in an arrangement. The Directors who retire at the present meeting are Mr. W. Addison and Mr. G. B. Frost, both of whom, being eligible, offer themselves for re-election. The Auditors of the Company, Messrs. Deloitte, Dever, Griffiths, and Co., also retire, and offer themselves for re-election.

REVENUE ACCOUNT FOR THE YEAR ENDING 31ST DECEMBER, 1889.

Dr.	£	s.	d.	£	s.	d.
To expenses in London—						
Directors' fees	1,000	0	0			
Salaries	824	17	0			
Rent	100	0	0			
Office expenses, &c., including telephone subscription	86	11	8			
Stationery, printing, &c.	48	16	0			
Legal expenses	5	2	10			
Postages and telegrams	29	5	0			
Depreciation on office furniture	18	0	0			
Audit fee	52	10	0			
Income tax	2	11	0			
Patent fees	28	16	0			
				2,196	9	6
,, Exceptional expenses				438	6	3
,, Indian agency expenses				493	4	10
,, Balance transferred to profit and loss account				7,119	1	11
				£10,247	2	6

Cr.	£	s.	d.
By net profit on working of the Company's exchanges to this date, including dividends and interest on shares and debentures held in subsidiary companies	9,995	6	10
,, Sundry commissions and interest	225	1	2
,, Transfer fees	26	14	6
	£10,247	2	6

PROFIT AND LOSS ACCOUNT, 31ST DECEMBER, 1889.

Dr.	£	s.	d.
To amount transferred to reserve fund	2,000	0	0
,, Amount transferred in reduction of value of stores at branches	500	0	0
,, Amount transferred in reduction of expenditure on formation of exchanges	340	13	0
,, Balance carried down	4,964	7	10
	£7,805	0	10

Cr.	£	s.	d.	£	s.	d.
By balance of profit and loss, 1888	4,413	4	1			
Less dividend 16th April, 1889	3,727	5	2			
				685	18	11
,, Balance transferred from revenue account, 1889				7,119	1	11
				£7,805	0	10
By balance				£4,964	7	10

BALANCE SHEET, 31ST DECEMBER, 1889.

Dr.	£	s.	d.	£	s.	d.
To capital authorised—						
300,000 shares of £1 each	300,000	0	0			
Capital issued—						
220,000 shares of £1 each, 11s. called	121,000	0	0			
3,242 shares of £1 each—issued as fully paid	3,242	0	0			
75,000 shares of £1 each—issued to vendors as fully paid	75,000	0	0			
				199,242	0	0
298,242						
Less calls unpaid				18	15	0
				£199,223	5	0
To sundry creditors				309	3	2
,, Bills payable				50	0	0
,, Unclaimed dividends				64	2	2
,, Exchange revenue, 1890—						
Subscriptions received for periods beyond 31st December, 1889				1,557	8	9
,, Reserve Fund				4,500	0	0
,, Profit and loss—						
Balance				4,964	7	10
				£210,668	6	11

Cr.	£	s.	d.	£	s.	d.
By telephone patents, goodwill, &c.	71,000	0	0			
,, Expenditure on formation of exchanges on hand to date	34,000	0	0			
				105,000	0	0
,, Shares, &c., held in subsidiary companies—						
11,825 preferred shares in Telephone Co., of Egypt, Ld., of ... £5 each. 3,875 deferred shares in Telephone Co., of Egypt, Ld., of ... £5 each. 12,261 shares in China & Japan Telephone Co., Ld., of .. ... £1 each. 14,810 shares in Bombay Telephone Co., Ld., of ....Rs. 25 each. 5,516 shares in Bengal Telephone Co., Ld., of.........Rs. 100 each. 45 7 % mortgage debentures of China and Japan Telephone Co., Ld. £100 each. Indian Government paper . ...Rs. 1,000	Valued at			89,474	3	2
,, Stores on hand—						
At branches	1,987	18	4			
Less reserved for depreciation	500	0	0			
				1,487	18	4
,, Office furniture	180	0	0			
Less written off to profit and loss, 1889	18	0	0			
				162	0	0
				196,124	1	6
,, Reserve invested—						
Deposited with bankers				2,500	0	0
,, Sundry debtors				6,767	11	2
,, Cash—						
At Alliance Bank, fixed deposit ...	3,500	0	0			
,, ,, current account ...	523	8	9			
In hand and with agents abroad ...	1,253	5	6			
				5,276	14	3
				£210,668	6	11

PROVISIONAL PATENTS, 1890.

APRIL 14.

5640. **Improvements in electric safety fuses.** Charles Watson, Victoria Works, Lambeth.

5645. **Improvements in electric railway apparatus.** John Byron Odell, 45, Southampton-buildings, London. (Complete specification.)

5678. **Improvements in electric tension regulators or apparatus for automatically controlling or regulating electric currents.** Julius Kalb, 47, Lincoln's-inn-fields, London.

5716. **Improvements in the method of and means for producing low tension alternating electric currents and applying the same to sundry purposes.** Edward Manville and William Leonard Madgen, 1, Queen Victoria-street, London.

5728. **Improvements in apparatus for regulating the speed of dynamo-electric and other machines.** Henry Harris Lake, 45, Southampton-buildings, Middlesex. (Theodore Marshall Foote, United States.) (Complete specification.)

APRIL 16.

5748. **Improvements in and connected with testing galvanometers.** Andrew Jamieson, The Technical College, 38, Bath-street, Glasgow.

5750. **Improvements in armatures for dynamo-electric machines and electric motors.** Rookes Evelyn Bell Crompton, 55, Chancery-lane, London. (Partly communicated by Waldemar Fritsche, Germany.)

5764. **Improved system of electrical inter-communication, and apparatus applicable for use therewith.** William Phillips Thompson, 6, Lord-street, Liverpool. (Arthur Wellesley Berne and Brownlee Wickliffe Taylor, United States.) (Complete specification.)

APRIL 17.

5804. **Improvements in electric miners' safety lamps.** Charles Pollak, 45, Southampton-buildings, London.

5836. **Improvements in apparatus for automatically controlling and regulating dynamo-electric machines and motors.** James Radcliffe, East Retford, Nottingham.

APRIL 19.

5910. **Improved method of and means for insulating electrical conductors, especially applicable to high tension currents.** Alfred James Jarman, 4, Moorfi-lds, Fore-street, London.

5894. **Improvements in converters.** Alfred Julius Boult, 323, High Holborn, Middlesex. (John Wesley Bookwalter, Germany.) (Complete specification.)

5916. **Improved electric alarm or battery bell.** Christen Rees Borné, 41, Eastcheap, London. (Actien Gesellschaft Mix and Genest, Germany.) (Complete specification.)

5920. **Improvements in accumulators or secondary batteries.** Paul Schoop, 46, Lincoln's-inn fields, London.

5923. **An improved electric servo-motor.** Charles William Sleeman, 37, Chancery-lane, London.

5925. **Improvements in telephony.** Milo Gifford Kellogg, 24, Southampton-buildings, London.

5926. **Machine for covering electrical conductors and cables with lead.** Sydney Pitt, 24, Southampton-buildings, London. (James Bassnett Atherton, United States.)

5938. **A new or improved secondary element.** Karl Emil Boettcher, 142, Fleet-street, London.

APRIL 19.

5942. **Improvements in the construction of electrical vent-sealing tubes for firing ordnance and like purposes.** Henry Capel Lofft Holden, Royal Arsenal, Woolwich.

5951. **Telephone slide index.** William Cooper Fletcher and David Craven, 36, Havelock-street, Sheffield.

SPECIFICATIONS PUBLISHED

1889.

5010. **Galvanometers.** Andersen. 8d.
7165. **Electrical distribution of energy.** Munro. 8d.
7794. **Phonographs.** Gouraud (Edison). 2s. 2d.
8780. **Electric switches.** De Facieu. 8d.
8815. **Interrupting electric circuits.** Thompson (Westinghouse Electric Company.) 8d.
13818. **Secondary batteries.** Ernst. 8d.

1890.

1281. **Secondary batteries.** Ernst. 6d.
3024. **Electric motors.** Lake (Parkhurst). 11d.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The receipts for the past week amounted to £5,208.

West India and Panama Telegraph Company, Limited.—The estimated receipts for the half-month ended April 15 were £3,593, as compared with £3,742.

Western and Brazilian Telegraph Company.—The receipts for the past week, after deducting the "fifth" payable to the London Platino-Brazilian Company, were £4,055.

United Asbestos Company, Limited.—This Company, whose chief offices are at Dock House, Billiter-street, E.C., have recently opened an additional branch office at Provident-buildings, Clare-street, Bristol. The Company's business is rapidly extending, and they have now branch houses at Glasgow, Newcastle-on-Tyne, Manchester, Liverpool, Cardiff, Bristol, Paris, and St. Petersburg.

Western and Brazilian Telegraph Company, Limited.—At the meeting of the Directors of this Company it was decided, after placing £7,500 to the renewal fund and £5,600 to the debenture redemption fund, to recommend at the forthcoming meeting a dividend of 6s. per share (free of income tax), making with the previous dividend a distribution of £4 per cent. for the year ended December 31, 1889, carrying forward £3,751.

Oriental Telephone Company, Limited.—The report of the Directors for year ending December 31, 1889, states that the net profit is £7,119, after writing off £438 for exceptional expenses at three of the Company's branches. Including the sum of £686 brought forward from 1888, the amount available for disposal is £7,805, which the Directors recommend should be dealt with as follows: To place £2,000 to the reserve fund; to transfer £500 in reduction of value of stores at branches; £341 in reduction of amount expended on exchanges on hand, which will then stand at £34,000; and to pay a dividend of 3 per cent., free of income tax, on the paid-up capital of the Company, other than the vendors' shares, carrying forward £1,237.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Anglo-American Brush	—	2½
— Pref.	—	1⅞
India Rubber, Gutta Percha & Telegraph Co.	10	18
House-to-House	4½	5
Metropolitan Electric Supply	—	5¾
London Electric Supply	5	2⅞
Swan United	3½	5
Crompton & Co., Pref.	—	5½
National Telephone	5	5¼

NOTES.

Berlin.—The Electro-Technical Association of Berlin has elected Mr. Thomas Alva Edison to be an honorary member.

Business.—Mr. Ernst Fahrig notifies us that after May 1st his cable and telegraph address will be "Ozonising London."

Welding Chains.—A chain welding plant has been ordered for the Charleston navy yard of the U.S. Government at a cost of 12,000dols.

Westinghouse Arcs.—The Westinghouse Electric Company, Pittsburgh, are installing a 50 arc light alternating-current plant in one of the new towns in Tennessee.

County Council Chamber.—The renovated building in Spring-gardens to be occupied by the London County Council has been carefully altered and fitted up. The building will be illuminated by electricity.

Ganz System.—It is stated that the Creusot Works are concessionaires for France of the Ganz patents. The Edison Continental Company will now, it is supposed, discontinue the manufacture of Zipernowski apparatus.

Tenders for Godalming.—As will be seen from our advertisement columns, the authorities of the town of Godalming are prepared to consider schemes for the electric lighting of their town and are inviting tenders, which must be sent in before 24th of May next.

Sunderland.—The Board of Trade have decided that having regard to the objection lodged by the Corporation they will not give their consent to the application of the Sunderland and District Electricity Supply Company, Limited, for an order for electric lighting in this town.

The Telegraph Conference.—At the International Telegraph Conference in Paris, which opens on the 15th inst., the Government of this country will be represented by Messrs. J. C. Lamb, H. C. Fischer, and P. Benton. These gentlemen will also represent the Cape Colony and Natal.

Cowles v. Herault.—A suit against the United States Aluminum Metal Company of New York, working the Herault process, has been brought by the Cowles Electric Smelting and Aluminum Company, of Cleveland. The alleged process of Herault is stated to be a gross infringement of the Cowles patents.

Blind Telephonists.—Dr. Plush, superintendent of the Philadelphia telephone exchange, has two blind operators in his employ. One of the girls taught her blind brother how to manipulate the switchboard, and since then another has obtained a position, and Dr. Plush has received applications for more than 200 blind persons.

Extension.—A new wing has been added to the works of Messrs. J. H. Holmes and Co., of Newcastle, which has been fitted with the most modern machinery, and is now in full operation. This firm have orders on hand for more than 20 steamship installations, besides many land installations, making more than 150 of their "Castle" dynamos on order.

Overhead Wires.—Lord Rosebery, in reviewing the works of the various committees before the London County Council on Tuesday, mentioned that with regard to the overhead wires Bill for the regulation and control of overhead wires, which was a matter of so much importance, they had withdrawn their clauses with regard to subways, at any rate for the present.

Trial of an Electric Light Company's Manager. The trial at New York of Mr. Charles Pierce, manager of the lamps of the Brush Electric Light Company, on a charge of manslaughter, was concluded on Wednesday. The evidence showed that the fall of an electric wire across Eighth-avenue, which resulted in a man's death, was purely accidental, and Mr. Pierce was acquitted.

Bromley.—Following a business visit by Mr. John Wright, A.M.I.E.E., a committee has been formed at Bromley, Kent, with a view to forming a syndicate for the electric lighting of Bromley, Bickley, and Chislehurst. Mr. Podger, whose works at Bromley are lighted with electricity, says he is more than satisfied, the cost being less than half that of gas and the light superior.

Electrical Tramways in Berlin.—Experiments with the object of replacing horse tramways by electrical tramways, says *Kuhlow's Gazette*, are shortly again to be undertaken by the Great Berlin Tramway Company. That company has commissioned the Allgemeine Electricitäts-Gesellschaft to erect a trial station for a new sort of electrical tramway. The experiments will be commenced shortly.

Tassel Circuit Closer.—The bell or other electric circuit closer of Mr. Joseph Dempf, of Washington, consists of a block of wood or other insulating material, bored in three different diameters. In this a circular stem, surrounded by a spiral spring, is mounted, and the circuit can be closed by pulling a cord or tassel instead of pressing on a press-button It should be useful for house-bell circuits.

Electrical Reports.—We have received the first number of "Whipple's Electrical Reports," published monthly at Campau-buildings, Detroit, by Mr. Fred H. Whipple. This consists of a revised list of central stations in operation being built or proposed in the States, with other information appealing to the electrical trades and contractors. It should prove of great value to those seeking to push or introduce business.

Institution.—The next meeting of the Institution of Electrical Engineers will be on Thursday, May 8th, when the discussion will be held on Dr. Oliver Lodge's paper "On a Lightning Guard for Telegraph Purposes and on the Protection of Cables from Lightning." A paper will also be read by Major Cardew, R.E., member, on "The Treatment, Regulation, and Control of Electric Light by the Legislature and the Board of Trade."

Electrical Execution Put Off.—Judge Wallace, of the United States Court, according to a Reuter's telegram on Tuesday, has granted a writ of Habeas Corpus, return able on June 17, in the case of Kemmler, the murderer, who was to have been executed this week by electricity on the ground that the Act passed by the New York State Legislature, under which the execution was to have taken place, is a violation of the United States Constitution.

Chatham.—The committee appointed by the Chatham Board of Health to consider the application of the Chatham, Rochester and District Electric Lighting Company for the substitution of 42 for 21 years as the period at which the authorities could, under the provisional order, purchase the undertaking, have come to a conclusion which is in every way satisfactory, the company's request being acceded to provided the Board of Trade will agree to the alteration.

Northampton.—At the Board of Trade enquiry held upon the action of the Hardingstone Local Board, it was stated that the Hardingstone ward representatives were practically unanimous in wishing for the electric light. Mr. Gottschalk, manager of the tramways company, gave evidence to show that his company were desirous of having electric power, and would have it from the local electric company if this company's price were favourable and they could supply them.

Metropolitan Mains.—At the meeting of the London County Council last week, Mr. Westacott (chairman of the Highways Committee) brought up a report, in which the Council was asked to sanction the Metropolitan Electric Supply Company laying mains in Lamb's Conduit-street from High Holborn to the boundary of St. Pancras parish, and in Red Lion-square, and in Great Ormond-street, Queen-square, Cosmo-place, and Little Ormond-street, on the usual conditions. This was agreed to.

Tenders for Westminster.—The Westminster Electric Supply Company are very busy completing the necessary legal details and plans of their central stations, and we understand invitations will shortly be invited privately for tenders for the engines, dynamos, apparatus, and the underground mains. Messrs. Crompton have already one large contract for underground mains in the Westminster district, but the above refers to stations not yet commenced. Three large stations will be simultaneously proceeded with.

Eastbourne.—The directors of the Eastbourne Electric Light Company have decided to persevere with their application for a provisional order authorising the company to charge 10d. unit, but should the Board of Trade refuse to allow more than 8d. to be charged, the company will not take up the order. In that event they will continue upon the present basis till next year, when another order authorising the charge of 10d. will be applied for. The present cost of producing the electric light is 8·8d. per unit.

Drilling Square Holes.—The introduction of the Ainley-Oakes drill for drilling square and other shaped holes is the object for which a syndicate has been formed. Messrs. Tyler and Ellis have improved the general design of the machine, and it is expected that a demand will arise from engineers for drilling special shaped holes when it is known this can be done. For crankpins, holes in fish-plates, machine tools, and so forth, as well as for dynamos and other electrical apparatus, the square drill may prove to have an extended application.

Lassoed by the Trolley.—A peculiar accident happened to Eugene Sullivan, conductor on a Blue Hill Avenue car, the other week. The rope which controls the trolley pole got caught in a span wire, and in some way entangled itself about Sullivan's neck. In an instant he was jerked over the dasher and hurled to the pavement. He was picked up and carried into a neighbouring drug store, where it was found that his head and hands were cut and his hips thrown out of joint. After being cared for Sullivan proceeded to his home in Dorchester.

Dover.—At the meeting of the Dover County Council, Mr. Alderman Adcock, discussing the electric light, said that the fact that the installation is required to be carried out in two years, instead of three, was not satisfactory, as in three years they could see what were the results in other towns. He thought this was one of the points that a deputation to the Board of Trade should ask to be rescinded, and he moved that the mayor and town clerk be appointed to act as deputation. This was carried, and the town clerk was asked to look up some information as to the introduction of electric lighting at Chelmsford.

Deptford Cables.—Our readers will be interested to know that a paragraph in a Manchester technical contemporary has drawn from Mr. Ferranti the first word he has yet publicly given upon the subject of his mains. Referring to the reports upon the rumoured breakdown of his cables, he says: "I am at loss to understand on whose authority you make the statements in the article in question. I beg to say that the insulation of the Ferranti mains has never broken down in the slightest degree, although subjected to over 20,000 volts dynamical, and very considerably higher electrostatic tensions. Neither have the bearings of the dynamos given any trouble since they were first bedded."

Ship Lighting.—The s.s. "Monte Video" was fitted with combined engine and dynamo by Mr. John Cochrane, engineer, Barrhead, near Glasgow. The engine is of the single-cylinder high pressure type, having 9¼in. cylinder, and 8½in. stroke, making 310 revolutions per minute. The engine and dynamo are on one bedplate, the dynamo being coupled direct. Several sizes of these engines are made, both simple and compound, and with automatic expansion gear. The dynamo used is a Siemens H.B. compound-wound continuous-current dynamo, giving 185 amperes at 65 volts, at a speed of 310 revolutions. The armature is built of bar conductors, and the magnets are magnetically insulated from the bedplate by massive brass feet.

Electrically-Welded Projectiles.—Lieut. W. M. Wood, of the United States Navy, who has been working with the Thomson Welding Company, has conceived the idea of manufacturing war projectiles by the electric welding process. The idea has been worked out, and patents have been taken. The usual process of the Government yards is to bore out solid metal at great cost. By welding a heavy tube of steel of the proper length to the head and butt of the shell, a projectile can be made in a few minutes which before took many hours. The patents will be developed by a special branch of the parent company, and are regarded as of immense importance. Large Government contracts are already waiting the formation of the company.

American Electric Apparatus.—Messrs. Shippey Brothers, Limited, have been appointed sole European agents for the Viaduct Manufacturing Company, and will in future hold stock in this country of the leading specialities manufactured by this firm, which include, amongst other appliances, American magnetos, signal bells, call boxes, fire and burglar alarms, thief catchers, switchboards, electric mats, porcelain ware, telegraph learners' instruments, carbon brushes, and switches, magnets, cut-outs, and other electrical appliances supplied by this firm. Special showrooms have been opened for this new department, in which a number of new and interesting American electrical novelties are on view.

Ealing.—At the fortnightly meeting of the Ealing Local Board, the draft of a proposed licence to the Board for electric lighting was brought forward. The surveyor having stated that no special provisions were required for the district, the draft was approved, and the matter ordered to be proceeded with. The clerk stated that immediately the application for the licence was deposited, he would advertise the application in the local papers, in accordance with the legal requirements. A letter was read from the Board of Trade, intimating that the Acton and Ealing Electric Supply Order would not be proceeded with. The clerk stated that he had written to the Board of Trade, asking whether the communication applied to the House-to-

House Company or to the Maxim-Weston Company, there being some doubt on the point.

Paddington.—After all Paddington has not settled the question of electric lighting. True, a resolution was passed by the Vestry on the 22nd April to withdraw opposition from all companies except the Metropolitan; but, as certain formalities had not been gone through, the resolution is a dead letter. In order to comply with the requirements of the Board of Trade, a month's notice has now been given for a meeting to be held on the 29th May; but even if the Vestry agree to the necessary resolution, it is very doubtful if anything will come of it this session. No Bill can be read a second time in the House of Lords after the 28th of June, so that if the necessary resolution is passed on the 29th day of May there will be barely a month for the Board of Trade to go through preliminary formalities, to print and introduce the Bill, to get it through all stages in the House of Commons, and read twice in the House of Lords. It certainly looks as if Paddington will have to wait another year for the electric light.

Local Authorities and Gas Shareholders.—In the House of Commons on Tuesday, Sir M. Hicks-Beach, in reply to a question put by Sir J. Pease, for Mr. O. V. Morgan, as to members of corporations being directors and shareholders in gas companies situate within the jurisdiction of such corporations, the assent of which was asked by promoters of schemes for electric lighting, said: The mere fact that certain members of local authorities are shareholders in gas companies within the district of the local authority would not of itself be deemed a sufficient reason to justify the Board of Trade in dispensing with the consent of such local authorities to provisional orders applied for by private promoters. If, however, it could be shown that the refusal of a local authority to give their consent is due to the votes of any members who were improperly influenced in giving those votes by their personal interest in local gas undertakings, I should be disposed to consider the expediency of directing an enquiry into an application to dispense with that consent.

Artificial Guttapercha.—We have received a communication from Dr. Purcell Taylor, of 26, Marchmont-street, Russell-square, which is of sufficient importance to the electrical industry. This is to say that he has succeeded in making a new insulating material, having all the properties of guttapercha, but with a higher dielectric resistance. The new substance, which is to be called "Purcellite," is, according to the writer, very tough and elastic. A piece of iron covered with it, he states, was hammered out flat, then bent and twisted until it broke, without even cracking the covering. The cost, it is added, is only about 1-40th that of guttapercha. It may be made any colour, and either flexible or rigid. The difficulty with regard to the supply of guttapercha is an increasing one, and it is very evident that such a material as this is stated to be, if it prove applicable practically and the resistance insulation keeps its value, would prove enormously useful in electrical industries. We shall be pleased to hear of practical tests having been made.

Altona.—The Altona municipal authorities have concluded a contract with Messrs. Schuckert and Co., electrical engineers, Nuremberg, by which the latter undertake to erect at their own cost an electric light central station, sufficient for all demands that may be made upon it, before the 1st of October, 1891. The town is to receive 6 per cent. of the gross receipts, rising to 10 per cent., and 25 per cent. of the nett profit exceeding 6 per cent. on the invested capital. The authorities reserve the right of approving the plans, and also the right of erecting installations for electrical power for industrial purposes and of purchasing the existing appliances at the end of certain periods. Notice to determine the contract can be given till 1911. The boundaries of the district to be illuminated are, provisionally, on the south side, the Elbe; on the north side the Lohmühlen and Friedrichsbader streets; on the east side the Hamburg boundary, and on the west side the Bahnhof street. The magistracy has the right to include adjacent portions of the town up to the 1st of July.

Brighton.—An enquiry by an inspector of the Local Government Board was opened at Brighton Town Hall on Tuesday relative to the proposal of the Town Council to spend £30,000 in electric installation for lighting and other purposes in a prescribed area in the centre of the town. It is proposed to charge 6d. an unit, and Mr. Shoolbred (who has been engaged as the engineer), Mr. Crompton, and Mr. A. Siemens, of the firm of Siemens Bros., agreed in saying that it could be provided at that price, or even lower, assuming that the demand reached 400,000 units per annum. They also agreed that the low-pressure system, with storage batteries, was the best to be adopted in a compact town like Brighton. Much opposition is being shown to the scheme, and early in the proceedings a petition, bearing 10,000 signatures, was handed to the inspector against the proposal. Mr. Lowther and Mr. Blaker, who are opposed to the scheme, desired to question some of the witnesses, but the inspector (Mr. Thomas Codrington) refused to allow them to do so, as being members of the Corporation, which was legally represented. This decision, it is understood, will be submitted to the President of the Local Government Board.

Carpet Sewing by Electricity.—The manager of the carpet department of a Chicago house has fitted up an electric carpet-sewing machine, which is likely to prove of wide utility in that trade. The machine is mounted on four large bicycle wheels. On a platform above the wheels is a strong sewing machine, while below is a C. & C. ¼ h.p. 110-volt motor, which drives it. The machine is meant to be run off the ordinary circuit, the house being supplied from an Edison station, and it is just one of those instances of the ease of application of electricity which we are looking forward to seeing in greater and greater abundance. Blocks are arranged to tighten and stretch the carpet, and basting pins are put in at intervals of a yard. The whole machine is started along the track parallel to the table on which the carpet is arranged. A boy or girl can start the machine, and either ride on it or walk ahead to match and pin the carpet. By hand, about 25 yards of carpet can be sewn in a day, and by this machine eight yards can be sewn in a minute. Mr. Ames, the inventor, claims that with six boys to work two machines an amount of work equal to that now accomplished by 300 girls can be turned out. The seam is superior to that sewn by hand, both in evenness and flatness.

Berrenberg Air Pump.—A new mechanical air-pump has been publicly exhibited to electrical and scientific men in Boston, U.S. It is suitable for making incandescent lamps, or for other work requiring high vacuum, and is invented by Adolph Berrenberg. It has been thought impracticable to produce a vacuum sufficiently good for electric lamps by any other means than the glass mercurial pump. The pumps now in use are necessa of small capacity, and the mercurial fumes render it unhealthy to work with them. In fact, the production of the vacuum is the most expensive and troublesome of the various processes necessary to complete the lamp. The Berrenberg pump is able to exhaust with ease more than 1,000 at once, and in a very short time. It does alone what would require hundreds of mercurial pumps. It takes up very little room, and will not poison those who work it. The lamps made by it are better than others and will burn longer on account of the uniformly good vacuum it produces. The pump has a strong syndicate interested in its development. The test, says an American account, showed that the machine is capable of doing what is claimed for it. Numerous experiments were made, all of which gave great satisfaction to those present.

Leeds Electric Lighting.—Mr. Waddy asked the President of the Board of Trade in the House of Commons on Monday, whether he could explain the circumstances under which the Board of Trade had refused the application of three limited companies for parliamentary powers to supply electric lighting to the borough of Leeds, notwithstanding the important demand for the electric light by the inhabitants; and whether that refusal was in consequence of the opposition of the local authority; and, if so, whether he could state whether the local authority had taken any steps itself to apply for powers for supplying Leeds with the electric light. Sir M. Hicks-Beach: The Board of Trade refused to proceed with the applications of the three companies referred to in consequence of their not having obtained the consent of the local authority as required by the statute. The Corporation of Leeds state that a committee of their body are engaged in an exhaustive and costly examination of the question of the supply of electricity, and they ask that the matter may be postponed until next year. The Board of Trade, in these circumstances, declined to dispense with the consent of the Corporation, but informed that body that, in the event of their not being prepared to apply for powers themselves next year, the Department would have to consider whether they could refuse to grant powers to other promoters.

Electricity in Engineering Workshops.—Mr. C. Frewen Jenkins delivered a paper at the Institution of Civil Engineers last Friday on the subject of "Some Applications of Electricity in Engineering Workshops." The paper contained a description of three workshop appliances driven by electromotors. The general requirements of small motors, suitable for driving drills and so on, were first considered, and the suitability of steel castings for the field-magnets was pointed out. A series of experiments on the magnetic properties of cast steel was described, and the permeability curve given with the chemical analyses of the samples tested. A portable drill, driven by a 1 h.p. motor with steel magnets, was then described, and the results of the tests of the motor were given and also the efficiency of the combined machine. This was followed by particulars relating to an electrical tube-cutter for cutting tubes out of boilers, and by a statement of the results of the tests of the motor. A number of different methods of connecting up the motor and switch for quick starting and stopping were discussed, together with their practical success when tried. An electrical travelling crane was next mentioned, and the practical requirements for both gearing and motors for the cranes were set forth with experiments on different forms of gear. The results of tests made on the power required to drive the crane were stated, and the efficiency was compared with that of the former method of driving with a fly rope. Lastly, a magnetic clutch, suitable for the gearing on the crane, was described, together with the test made of its power with varying magnetising currents.

Electric Welding.—Sir Frederick Bramwell seems quite to have fallen in love with electric welding. He was asked to give a report upon it, and insisted upon first reading a paper before the Civil Engineers. He is very much taken with the process, and it will not be from want of his support that it should be well introduced in England. The welding apparatus which was installed for the occasion at the theatre of the Civil Engineers was left over, at the suggestion of Mr. Preece, to the meeting of the Electrical Engineers the following—*i.e.*, last—Thursday. Dr. Oliver Lodge was perhaps a little incommoded, both by the largeness of the affair in its wire gauze case taking up the available room and also by the natural curiosity of members to see it at work. This was not for long, for his electric lightning filter soon rivetted the attention of his audience. But when this was over, Mr. Fish, accompanied by two stalwart smiths, began to turn on the current. A mysterious whirring behind, Mr. Preece informed the meeting, was the sound of a 16 h.p. engine (working up to 50)—a source of power that must be kept in mind when contemplating the wonders of electric welding. Pieces of thick iron bar, angle iron, hard tool steel, were each in their turn rapidly brought to a red and a white heat before the audience, a sprinkling of borax and a few rapid strokes with the hammer sending white hot sparks all around; then the piece was rapidly unloosed, and the smiths went at it, ding-dong, exactly as in an ordinary smiths' shop on an ordinary anvil, and in less seconds than it takes to describe the piece was welded amid the applause of the onlookers. Tests were then made by bending double, with perfectly satisfactory result. Wires were also rapidly welded with the automatic cut-off welders.

Local Authorities and the Board of Trade.—A deputation from a large number of town councils and other local authorities attended at the offices of the Board of Trade, Whitehall, on April 24th, with reference to the model order under the Electric Lighting Acts recently issued by the Board of Trade. The deputation was introduced by Mr. H. S. Wright, M.P., who described the members as thoroughly representative of the interests involved. The objections of the local authorities to the order had been formulated at a meeting in Westminster Palace Hotel, and they were placed before the Board of Trade officials *seriatim*. Mr. Gane, town clerk of Blackburn, pointed out that clause 6 of the order was entirely new, never having appeared in previous orders. It meant that if the undertakers of any system of electric lighting were to go outside their area the order they had obtained might be revoked. He maintained that such a provision was entirely unnecessary, because if the undertakers exceeded their powers they would be *ultra vires*, and could be dealt with at common law. The clause was one which was not quite fair, though it could be made an advantage rather than a disadvantage by being amended so as to give the Board of Trade power to authorise the laying down of mains in adjoining districts. Mr. Calcraft said the Board of Trade were inclined to agree with Mr. Gane. Mr. Souter (Darlington) stated the objections felt to the clause requiring local authorities to give security, and this it was agreed to omit. Mr. Calcraft further notified the deputation that clause 18, giving power to revoke an order because of a defect in the construction of works, would not be gone on with, as they were going to put in other clauses which would meet that. Alterations were agreed to in several minor matters to which objections were taken, and the deputation then withdrew.

Fast Telegraphing.—An interesting competition was held on April 10 in New York, in which prizes were given for speed and clearness of telegraphing. The copy was a printed slip, with which the competitors were allowed to make themselves familiar. The ladies' prize of 50dols. was obtained by Miss K. B. Stephenson, with 217 words in five minutes. The prizes for old telegraphists (those in service prior to 1865) of 50dols. was won by A. S. Ayres, 229 words. The next event was the most eagerly anticipated, and the result was to display the fastest Morse that has ever been seen up to that date. Some of the best-known telegraphers in the country were in the competition, says the *Electrical World*, and the beauty, clearness, and rapidity of their sending made the occasion one long to be remembered. A surprise was in store, however, even for the telegraphers themselves, for the prize was secured by a "dark horse" among the contestants, Mr. B. R. Pollock, jun., train dispatcher of the New York and New England Railroad at Hartford. He started out at a pace that surprised the audience, and not only kept it up, but increased it until at the end of five minutes he had 258 words to his credit, breaking all records and going more than 10 words ahead of his nearest competitor. Although the sending was very rapid, it was not at all as distinct as that of some of the others, and the judges, being unable to agree, asked Messrs. Gibson, Roloson, Pollock and F. L. Catlin, son of Mr. Fred. Catlin, manager of the tournament, the four showing the greatest speed, to make another trial. In this second attempt Mr. Pollock beat even his previous record, sending 260 words, just 52 words a minute, while the speed of the other contestants fell off a little. Mr. Gibson, who sent 238 words in the second trial, gave a singularly clear cut and distinct exhibition of speed, every character being easily readable. The remarkable fine quality of his work seemed to some of the judges to counterbalance the greater rapidity of Mr. Pollock, but as there were among the audience (as well as among the judges) those who were willing to say that they could follow the high speed of the man from Hartford, he was awarded the first price of 100dols. Mr. Gibson got the second prize, 70dols., and Mr. F. J. Kihm, who sent 238 words, third prize, 30dols., while Mr. W. L. Waugh, who sent 229 words, was given the United Press and Sabin prizes. As it was maintained by the other competitors that it would be impossible for an operator not familiar with the matter to read Mr. Pollock's sending at 52 words a minute, a sweepstake of 100dols. is to be arranged to send 1,000 words of ordinary press matter not to be seen by contestants till the start.

Central London Electric Railway.—The further consideration of the Central London Railway Bill was continued on Friday and the following days. Sir Benjamin Baker, in further evidence, said there could be no possible danger to people suffering from an electric shock. The system proposed was not an experiment, but an absolute certainty. What they had to do was mere child's play as compared to the Metropolitan Railway. Fourteen miles an hour, he said, was the average speed proposed. Originally several of the gas and water companies had objected, but had now abandoned their opposition. Sir John Fowler was also examined, and stated the risk of disturbance to property was practically avoided by the system adopted in connection with the projected railway. Electricity was now removed from the experimental stage as a means of traction. It was idle to suggest that there was any necessity to postpone a project of the kind under consideration in order to enable further information to be obtained of the efficacy of electrical traction. The City and Southwark Subway was a case in proof that the scheme was practicable. The tunnel would be lighted by electricity. This closed the case for the promoters. On Monday Mr. Littler, Q.C., addressing the committee in opposition of the scheme, said the owners of the land had frontage towards the railway of the value of a million pounds. The leases were falling in, and if the railway were authorised he contended the rents would decrease. The principle of electric railways in America had never been practically tested underground. No good, he contended, would be conferred by the proposed railway, which would be less advantageous and more costly to the travelling public of the metropolis than the present system of omnibuses. Respecting the capital, he pointed out that before the company could make a dividend on £3,000,000 they must earn £300,000 a year. There could not be the slightest doubt that the scheme was to be financed by shares on the public, a thing which no parliamentary committee had yet recognised. Architects and surveyors were examined as to the injury done to buildings by the Southwark Subway. On Tuesday, Mr. Cripps, Q.C., addressed the committee in support of the opposition of Lord Portman, the Vestry of Marylebone, owners of property in Oxford-street and Holborn, and owners, occupiers, and frontagers on the City part of the line. He submitted that the scheme was impracticable, and that it was not one in which such exceptional favours as were asked for should be given. Witnesses were examined in support of the interests represented by the learned counsel. On the sittings being resumed, Mr. W. B. Lewis, C.E., said he did not think the proposed railway could be constructed in Cheapside without damaging the buildings. The fear of disasters from the construction of the railway had, in his mind, been increased after an inspection of the City and Southwark Railway, where considerable damage had been done, notwithstanding that great ingenuity and skill had been shown in the construction of that line. He feared damage to Bow Church in Cheapside. He should like to see the railway succeed, but he thought the experiment should not to be tried in Cheapside and the Poultry, the risks were so large. He thought Mr. Greathead, the responsible engineer for the Bill, was far too sanguine, though he admitted that he was the most experienced engineer in this country on such work as proposed by the Bill. Westminster Abbey was constructed on a bank of gravel, and there was no subsidence when the Metropolitan Railway was constructed. Mr. John Belcher, architect, next gave evidence with regard to Mansion House-buildings, in Victoria-street, and the Poultry. Mr. Fowler, surveyor to the Portland estate, said that the estate extended from Marylebone-lane to Berners-street on the north side of Oxford-street, and represented £848,000. The proposed line would run within a few feet of those houses, which, if it was necessary to underpin, could only be accomplished with considerable risk. Mr. Gainsford, residing in the Borough High-street, said his premises since the Southwark Subway had been constructed had seriously cracked. Mr. Hughes, an architect, handed in a cartoon showing the result of borings he had made in Oxford-street.

OPENING OF THE EDINBURGH EXHIBITION.

(FROM OUR SPECIAL CORRESPONDENT.)

A special train containing the Duke and Duchess of Edinburgh, together with a number of other distinguished guests, including representatives of the press, was run on Wednesday morning to Edinburgh. The weather was very fine and great enthusiasm was shown by the inhabitants. Great crowds attended the arrival of the Duke and Duchess of Edinburgh, and salutes were fired from the Castle guns. Special arrangements were made for the reception of the guests, and a banquet was held in the evening.

The opening ceremony took place at half-past one yesterday in the grand or music hall of the exhibition. The exhibits are in a more forward state than is usual at opening, and the officials have made great efforts that the exhibits should be in place. Still, a good deal is in unfinished condition. The locomotive section contains splendid examples of oldest as well as of most modern engines. The electrical machinery hall and the extensive lighting seems well designed, and the light is well distributed. The effect is certainly very effective, and gives great credit to Mr. Bryson, the electrical engineer. . Arc lights are very plentifully used, and there are no less than 95 lamps of 2,000 c.p. in the machinery hall. Sunbeam lamps are used in the music hall and in the first-class dining-rooms, and of these there are 110 of 200 c.p. each. A fine art gallery has been added, in which a large number of Scottish pictures are shown. A special and interesting exhibit of Belgian pictures has been sent over. The representatives of the press were admitted to a private view on Wednesday. The general exhibits are extensive and varied, and are capitally arranged. All the officials and exhibitors speak highly of the efforts of Mr. Lee-Bapty, who seems to have the genius for organisation. It will be remembered that the first suggestion for such an exhibition came from Mr. A. R. Bennett, the genial and able manager of the telephonic system of the district. The suggestion was for an electrical exhibition, but work grew, and from the original germ has grown a large and very important general exhibition. The details of the exhibits, so far as our readers are interested, will follow in due course, meanwhile it is interesting to know that the citizens of the finest city in the world have entered into the work with great spirit, and seem determined to make the exhibition a great success. We believe that if the exhibitors will fall in with the views of the executive a series of trials will be made of electrical apparatus.

The address of the executive council to the Duke, among other things, said it was intended, in the first instance, that the exhibition should be confined to objects within the sphere of electrical and mechanical engineering, but the desire to take part was found to be so general, not only at home but abroad, that it was necessary to enlarge its scope, and this has resulted in an international, and, practically, universal exhibition, which, the council trusted, His Royal Highness would find to be worthy the honour conferred by him in coming to open it. The original object has always been kept well in view, and the illustrations of the various inventions in and applications of electricity occupy the foremost positions. Mechanical engineering is worthily represented, while the collection of locos, to railway work generally, is probably the finest ever seen in this kingdom. The general industries of the country occupy a large space, and will be found exceedingly interesting and instructive. Reference was made to the generous support received from other countries; more than half the main building is devoted to foreign sections.

To this address the Duke replied, thanking them in his own name and that of the Duchess for the invitation to attend the opening of this important and interesting exhibition, and for the courteous and hospitable reception. He would convey to the Queen the expression of loyalty and the hope she would find it in her power to visit the exhibition during the year. He congratulated the committee on the excellence and generality of the exhibits.

After the reply the Edinburgh Choral Society sang Psalm viii., as specially composed for the occasion by Mr. H. MacCunn, and the exhibition was declared open.

THE REIGNIER-BARY DYNAMO.

We have already (p. 251, March 28) alluded to a new type of dynamo introduced by MM. Reignier and Bary, in which, by the arrangement of the armature, the output is very greatly increased for the weight of the machine. The following is the translation of the paper read by M. Ch. Reignier before the Société Internationale des Electriciens:

The dynamo which I have the honour to present to the Société Internationale des Electriciens is a continuous-current dynamo, which offers over all known types—from the point of view of specific utilisation of the materials employed—a very great superiority, the extent of which I shall enable you to judge.

In the improvement of continuous-current dynamos, the researches of to-day are principally upon the subject of the diminution of the weight, for this carries with it not only the immediate advantage of lightness, but also that of price, which generally decreases with the weight of the machine.

This tendency to improve dynamos in this direction is explained by this fact: the only two general terms of comparison of dynamos between themselves are the "efficiency" and the "specific output."

Now, the figure obtained for efficiency having now become almost a maximum, or at least a figure which leaves little to be gained, there remains no true improvement to be made, save in the number of watts that can be produced with a given weight of machine.

The factors of specific output are, as is known, in the first place, the speed and the intensity of the magnetic field. The first—the speed—need not be here considered; for all dynamos whose armatures are formed by copper windings are constructed to run at a certain speed which, rightly or wrongly (wrongly, I think we may say) is considered at a maximum. Next, as to any great increase in the strength of the magnetic field, it is equally known that this cannot be accomplished—as we are already in the higher parts of the magnetising function of the machine—save by an expenditure of electric energy far more than proportional to the effect produced. Neither of these factors can therefore really contribute to diminish the weight of a machine without leaving the admitted laws of construction or without losing in the efficiency.

In the value of the E.M.F. induced there is also concerned, besides the speed and the intensity of the field—which we suppose constant for all machines—the length of the wire in the armature. If, therefore, without changing the dimensions of an armature a greater length of wire of the same section can be placed on the armature, the current output will remain as before, but the E.M.F. will have increased proportionally to the increase in length.

Such a result can only be obtained if the magnetic field does not partake in this increase. Unfortunately, this cannot be done with the known types of dynamos. Whether it be a drum, ring, or disc armature the air space is always increased if copper be added to the armature, and the field is accordingly diminished.

The improvement carried out in our machine lays in the means of adding to the quantity of active metal in the present type of dynamo without diminishing the field. It consists in replacing the copper wires of the ordinary machine with metallic plates, or strips, which are composed, in variable proportions, of copper and of iron; the space between the iron of the pole-pieces and the magnetic core of the armature can in this manner be rendered extremely permeable.

This modification can be carried out with all types of armatures.

Suppose, for example, that we have a ring formed by the building up of iron sheets, as in the ordinary ring armatures. We will represent it in accompanying figure.

Upon the exterior circumference are placed the strips serving to conduct the induced current. These strips are placed in the following order: Iron, copper, iron, insulation; iron, copper, etc.; each couple (or triple) iron-copper-iron, replaces one wire of the ordinary machine.

Against the interior circumference are placed strips which need not be magnetised, and are either wholly copper or insulation. The space lost in passing from the external to the internal circumference is thus gained by the conductibility of the metal.

The connections of the opposite strips of the armature are made at the ends by plates of copper, and the contacts at the junctions are simply obtained by a strong pressure of the extremities, which have been cleaned with care.

With such an arrangement an output of 40 watts per kilogramme (18·2 watts per lb.) of machine can be obtained.

The circumferential velocity for normal speed is 10 metres per second, which is the minimum of the speed ordinarily chosen.

The following table gives the specific output of the different types of ordinary machines of which we have been able to obtain particulars:

Edison dynamo (1885)	6·7 to 11·6
Edison dynamo (1889)	9·5 to 12·2
Thury (1886)	11·8 to 15·2
Dulait	8·3 to 13
Ganz	6·1 to 11
Rechniewski	19·0 to 26·4
Breguet (1886)	10·2 to 24

It is to be noticed that, of all these machines, those which have the largest activity are those which at the same time have the greatest linear velocity. Even under these conditions we have already a very great superiority from the point of view of weight; but to make the comparison perfect we ought to raise the velocity to 16 metres per second, which would give an output of 64 watts per kilogramme of machine.

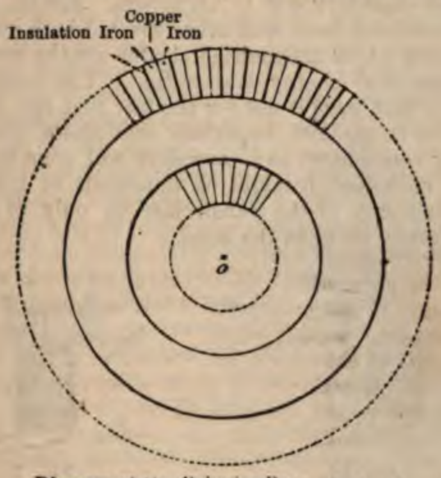


Diagram of the Reignier-Bary Armature.

Why, it may be asked, have we remained at so small a velocity when the employment of metallic strips instead of copper wire would guarantee a resistance to centrifugal force considerably greater than what would be admissible in others? In this we have simply followed a question of routine. It is not the custom to exceed a certain speed. We have, in this instance, kept to the usual figures, content to mark the machine for a smaller power than that which it can produce.

To continue the comparison, we will take different types of machine of the same power.

a. The Rechniewski dynamos produce 800 watts per kilogramme of copper in the armature, and 270 watts per kilogramme of total copper.

b. The Desroziers dynamos give 250 watts per kilogramme of total copper.

c. The Edison dynamos give 500 watts per kilogramme of copper in armature, and 92 per kilogramme of total copper.

d. We have found in our own first trial machine a production of 1,800 watts per kilogramme of copper in armature, and 445 kilogramme of total copper.

These figures are résuméd in the following table:

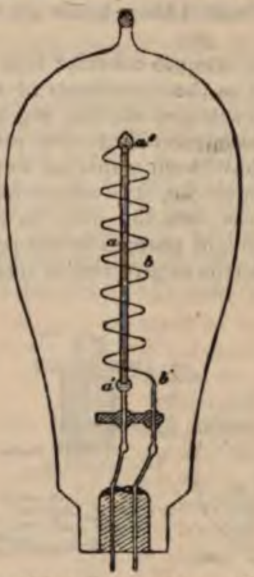
Watts per kilog.	Rechniewski.	Desroziers.	Edison.	Reignier-Bary.
Of dynamo	21·5	21	9	40
Of copper in armature	800	(?)	500	1,800
Of total copper	270	250	92	245

Lastly, the electric efficiency of our dynamo is 94 per cent., and the commercial efficiency reaches 90 per cent. A machine of one-third the weight, which produces the same out-put, is, we think, of sufficient interest to bring before your notice.

LANGHANS INCANDESCENT LAMP.

The Langhans incandescent lamps to which we have already alluded, has been patented and brought out by the Langhans Electrical Company of Berlin. The lamp has the appearance shown in the accompanying illustration. The principal point of novelty is the vertical support *a*, which sustains the spiral filament *b*. This support is connected at a^1 to one of the electrodes and at a^2 to the spiral, which is joined at *b* to the other electrode.

The support consists of a core and a surrounding envelope. The envelope is composed of two metals or alloys of which the coefficient of expansion is different. By reason of the heat produced by the radiation there is a difference of expansion between the core and the envelope, and the internal tensions which result prevent all lateral bending.



The Langhans Incandescent Lamp.

PHENOMENA OF ALTERNATING CURRENT INDUCTION.*

BY PROF. ELIHU THOMSON.

(Concluded from page 335.)

A small motor of a curious type has been made, utilising the principle of shading the pole by closed circuits. A laminated ring (Fig. 12) is wound over with wire, but has a slot cut through it, dividing the ring, and causing it to present two pole faces opposite to each other at the cut part. Each pole is arranged by a set of closed copper bands to be "shaded," as I term it. A copper disc free to turn introduced by one edge into the slot turns rapidly and exerts some power.

Removing the disc it is found that a silver coin can be inserted into the slot and will be drawn into it and propelled with some force through the same, while a lead coin, or coin of base metal, will be scarcely affected. This is due to the vigorous currents which can exist in the silver, owing to its high conductivity, while the very low effect of the lead is due to the opposite cause.

To obtain a rotary effect on a copper disc we can, however, simplify matters very much by using no closed circuit at all, nor even a steel piece. We may place the disc partly over the alternating pole and then hold over the disc a bundle of iron wires or unwound core, taking care to offset its axes to some extent from that of the pole towards which it and the disc are presented. The result is at once a rapid revolution of the disc in the direction of the offsetting.

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* Abstract of a lecture delivered before the American Institute of Electrical Engineers at Columbia College, April 2, 1890.

The rotary effects are utilised in the construction of electric motors and meters of more or less merit. They are capable of very great variation by changing the forms and relations of the devices used.

Some curious modifications of the effects are found in the revolution of copper balls or cylinders. A hollow copper ball may be laid on a plate of copper (Fig. 13), or within a ring of the same metal, and set in gyratory movement, its direction of rotation as well as the position of its axis of rotation depending on the relation of the ball and the plate on which it rests or the ring which encloses it in relation to the alternating pole which is used to set it in movement.

It will even rotate on a horizontal axis while resting on a plate of copper; this requires that it rub its equator upon such surface and overcome the friction.

Placing the ball in a vase of water in which it floats and supporting the vase over the pole upon which has been laid a plate of copper partly covering the pole, gives vigorous rotation of the ball in the water. Several balls of various sizes may be placed in the vase, or a copper dish substituted for the plate, or the ball and dish both used together (Fig. 14). The effects of these latter are both amusing and instructive.

We need scarcely stop to consider that these actions are brought about just as the movements of the discs were set up by induced currents and shifting magnetic lines that are retarded by the closed circuit currents set up in the plates, rings, etc., which have been employed to modify the field.

But, as we have shown, it is not necessary for obtaining some of these effects that the field be modified by closed circuit currents. Slight changes in the position or shape of parts may be sufficient to give rise to rotary effects. Thus we may place a cone or wedge of iron on the alternating pole (Fig. 15), and hold near it a copper ring mounted so as to be able to revolve. The ring in this case is best provided with a laminated iron interior, which supports it and enables it to be easily mounted on a shaft. The copper cylinder revolves, and its direction is such that it seems to be blown around by a blast from the edge of the wedge or point of the cone.

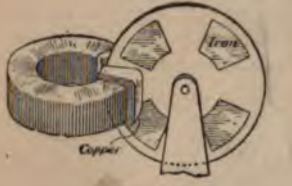


FIG. 12.

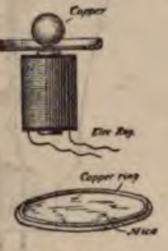


FIG. 13.

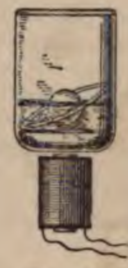


FIG. 14.

A curious electrical gyroscope is constructed as follows: A vertical pivot projects from the centre of the alternating pole (Fig. 16), upon which pivot is hung a horizontal rod, bearing on one side of the pivot a copper frame, in which is carried a copper ring or wheel with an iron inner portion, such ring or wheel being delicately pivoted in the frame in the usual way. The rod bears on its other end the counterpoise or balance weight. The copper frame bearing the ring is placed in an inclined direction with reference to the horizontal. Under these circumstances rotation is given by the alternating field in which the instrument is placed, and the properties of the gyroscope are exhibited. It is needless to say that a little ingenuity may modify the instrument in form, or lead to the construction on similar principles of a variety of curious devices, receiving their movements from the actual space, as it were, in which they are placed, and without direct connections of an electrical or mechanical character.

There is a growing tendency among electricians to regard the effects of what is called an electrical current in a conductor to be due, in large part, at least, to a movement of particles, or to a transmitted strain which has its place entirely outside the wire or conductor, and in the space around such conductor. The wire and current in it are regarded simply as the central core of a set of disturbances in the medium surrounding it, by which medium the energy of the current is actually transmitted, if the current itself is not merely an effect of such a set of disturbances in the surrounding medium.

Viewed in this light the phenomena we have been considering are seen to be simply the result of modifying these outside effects by conducting or magnetic masses placed in the medium subject to disturbance. The coil conveying the current sets up a changing set of strains in the ether around it, or rather the coil itself is only the centre of such strains transmitted into the medium surrounding the wire from the source of current used, which may be a dynamo located in a central supply station. The changing set of strains around the coil used in the experiments can set up current in other conductors than the coil subject to their action. Thus are produced the induced currents in the copper rings, balls, plates, etc., used. Such currents react on the medium, and modify the distribution of strains, and so give rise to the movements and other phenomena displayed.

The relation which exists between a primary inducing coil and a secondary coil in an inductive apparatus or transformer is of the same nature. The secondary coil is merely a conductor immersed in the medium which surrounds the primary coil. The latter and the wire leading to it from the source of current is but the core of a set of disturbances or strains in the ether surrounding it, and in which the secondary coil is immersed. Hence, the coils, though insulated from each other, are yet both immersed in the medium whose transmitted strains are the real expression of electrical energy transmitted. The result of this relation is that were it not for the fact that the coils must necessarily be made of imperfect conductors, the amount of energy transmitted to a secondary coil from its primary could be unlimited, it might be thousands of horse-power, and the iron core of the transformer be only of such size as to be easily lifted in the hand.

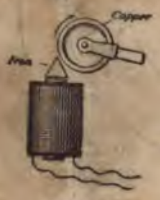


FIG. 15.

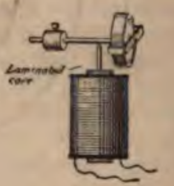


FIG. 16.

Let us imagine the primary and secondary coils of an induction apparatus made of pipe, through which a refrigerant is circulated, or around which a powerful refrigerating action is exerted, such as might be obtained by the evaporation of liquefied gases, and in such case the resistance of the coils would become very small indeed. The coils could carry large currents without loss, and the amount of energy obtained in the secondary would almost keep pace with the energy supplied to the primary. A remarkable example of this wonderful capacity for energy transmission is seen in some transformers for electric welding, in which 20,000 to 30,000 watts, or from 30 to 40 h.p., are transferred to the secondary coil from the primary, apparently, while the iron core or magnetisable core is of quite moderate dimensions. In fact, the iron core has but little to do with the capacity for transmission of energy by induction, though it effects the E.M.F. set up in the turns of wire of the coils.

Could we imagine an open coil without iron, composed of two interwound coils of copper wire or tubes insulated from each other, and kept at the lowest possible temperature, so as to practically abolish the resistance of the copper, we would have an apparatus of the very highest efficiency for the transfer of electrical energy from one circuit to another, and one which could be of very moderate size and yet transfer enormous amounts of such energy, to be used for lighting, metal working or other purposes.

There has only been time in this discussion to touch upon a few salient features of our subject, about which a volume might be written at the present time, the object being to bring to the notice of the institute rather the experimental demonstrations only, stripped of such theoretical considerations as would, if incorporated in this paper, have taken up much more than the space allotted to it, and perhaps have exhausted the interest of the hearers.

WYNNE'S URBAN ELECTRICAL TRAMWAYS.

Some weeks ago, it will be remembered, we received and printed the description of a new system of electric traction designed by Mr. Frank Wynne, together with the report thereon by prominent members of the Brush Electrical Corporation. It almost appeared from this report that the Brush Corporation were intending to take up this system, but so far we have not heard that this is the case. It is difficult of course to decide upon the comparative advantages of a new departure in traction system without a practical trial, or definitely to decide on its utility without careful tests in actual running. We have not had the opportunity of judging of the system practically, nor so far as we are aware has there been any attempt to demonstrate the proposed system in practice—at least, not the least mention has been made of this.

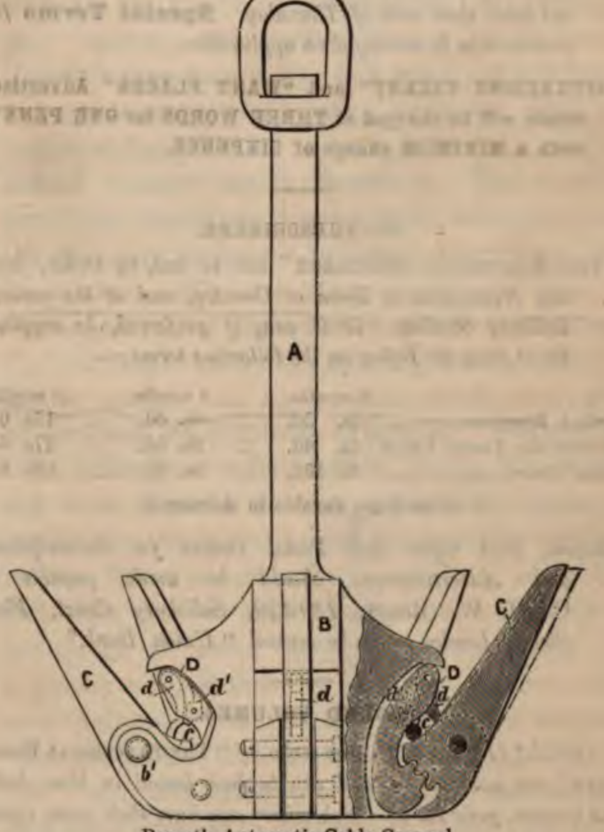
We have received from Mr. Wynne (whose address is 5, Westminster-chambers) a further pamphlet or prospectus on his system, entitled as above, but it seems more correct (we are under correction if Mr. Wynne has a network of urban electrical tramways) to call this Wynne's urban electrical tramway "System." We wish to be fully understood in this matter. We have not the slightest objection in the world to inspect and to praise, if possible, any system of electrical traction if it seem to prove advantageous, and especially and above all if it has been practically tested; but we must decline, merely because the diagrams are published, to consider the system as definitely accepted, and as such a suitable subject for the public to spend their money upon. Even if the system were to be seen in practice, there would be probably many and various opinions upon the advantages of the system, which would remain to be tested by practice, and until this is the case we must hold ourselves open to judge ourselves of the apparent advantages, judging simply from the drawings, the statements of the inventor, and previous experience.

The prospectus or memorandum is sent to us for insertion, and Mr. Wynne hopes we shall be able to endorse his views and his notes upon other systems of electrical traction. We are not in the position to do the one, nor inclined to do the other. Mr. Wynne's system, as will be remembered, is a closed conduit system—*i.e.*, with no opening through the ground—and the essential part of the system is a zigzag or crenellated strip of iron fixed among the cobblestones, divided into short lengths and charged as the car moves along. The system is ingenious, but embodies so many points of doubt and acknowledged difficulty that it is, at the very least, extremely uncertain whether the disadvantages would not counterbalance the advantages. In the first place, the charged plates are, to some extent at least, exposed. This, however, is not the chief difficulty. In the next place, it would seem that the contact-boxes are to be placed at the space of every nine feet or so. This in itself is an item of considerable perplexity; but when it is remembered that each of these is a piece of electrical apparatus needing to be occasionally inspected, repaired, or otherwise attended to, it can hardly be considered as a simplicity. Then, again, the insulation, always the most difficult point in an underground system, is cavalierly dismissed with ordinary grouting. The main electric conductor, again, of course, is not able to be inspected or repaired without taking up the road. A further great difficulty will necessarily be, in wet or muddy weather, the obtaining of proper contact, and the practical hitches which are likely to occur in any occasional failure through mud and dirt, though possibly small in a single case, might very possibly mount up to a serious inconvenience on the whole length. Notwithstanding all this, we should be delighted to see the system prove itself practical and successful, and we shall be pleased to come and see a line in operation.

Meanwhile, as to other systems. Mr. Wynne says other systems have "been before the public for eight years; unlimited sums of money have been at the command of those advocating it, with the result that no material advance whatever (!) has been made." These remarks apply to self-contained accumulator cars. This statement is simply not true, and could hardly be made by anyone conversant with the present state of electric traction, when on all hands projects are on hand for the extensive development of electric tramways on various systems. A further delusive statement is made, which we cannot allow to pass unqualified. Mr. Wynne says: "At Brussels, where the accumulator cars have had the largest and most extensive trials, they are now being finally given up." This statement, though true in fact, takes into no consideration concomitant circumstances to which we have already alluded, prominent amongst which were certain municipal difficulties, with other matters, which are far from yielding the conclusion intended to be drawn by readers of the memorandum in question, namely, that accumulator traction is tried and doomed. This is, so far, exactly the opposite that the long and steep line at Birmingham will shortly be opened with storage cars, while the successful running of the cars at Barking-road have been proceeding for months. There is no doubt a successful direct-current system is a great desideratum, but the way to compete with progress in storage traction in England is not by alluding to Belgian failures, but by fair comparison with the best English success.

BENEST'S SUBMARINE CABLE GRAPNEL.

The difficulty in searching for and raising a broken or defective submarine cable is twofold; first, the difficulty is to find and hook the cable, but after this considerable care is necessary not to let it slip away before it is completely raised to the surface. It can easily be understood that a slight accidental downward movement of the ordinary grapnel might, and sometimes does, let the cable slip, and the whole work has then to be commenced again. In the improved submarine cable grapnel, patented by Mr. H. Benest, of the Silvertown works, an ingenious arrangement is adopted to make the grapnel such that it will not merely hook a submerged cable, but automatically hold it firmly in its grasp when hooked. This grapnel is shown in the illustration, from which the action can be readily understood. The cable is shown in section at *c*. The flukes are all pivoted in b^1; the cable on being hooked slipped down between D and C, and is tightly gripped on raising the grapnel; *d* is a locking pawl and d^1 a tumbler piece, which effectually prevents the cable from escaping until released by hand after the recovered [illegible] is suitably secured on board.



Benest's Automatic Cable Grapnel.

THE

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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IMPORTANT NOTICE.

We may occasionally follow the lead of our American Contemporaries, especially when they point out a serviceable way. They are not backward in asking their friends to do all they can for the welfare of the paper. We ask our friends to remember us. No paper that we know ever refuses Subscribers or Advertisers. Nor do we ; in fact, we invite them, believing that they will get full value for their money.

Specimen copies of the paper will be sent on request.

THE MODEL ORDERS.

The Board of Trade has lately issued two model forms of provisional orders. Form No. I. is that for "Undertakers being a local authority." What a lugubrious sound has this word "undertakers." It seems as if the knell has been sounded, and the last act before oblivion commenced. "Supply" companies might have suggested "suppliers." However, a "rose by any other name," etc., and "undertakers" or "suppliers," the industry will live or die without the assistance of a word. Still to connect a young, vigorous, and thriving industry with an "undertaker" is uncouth. Form No. II. is for undertakers being a "company or person." We remember a caution issued to journalists some time ago by H.M. Government, that the Crown claimed copyrights and would proceed against infringers. It seems necessary that everyone connected with the industry should know the wording of these orders, and though either of them may be obtained for the small sum of fourpence, we trust that no pains and penalties will visit us for reprinting one of these orders, which we commence in another column. The greater part of each order is similar, but any reader will understand that clauses which in Form II. require notice to be given to the "local authority" as well as to the Board of Trade, or to the local authority only, are differently worded in Form I. A few clauses appear in Form I. which have no counterpart in Form II. Thus Form I. contains a clause relating to the purchase and use of lands not found in the other order. Similarly, a clause in one relates to the application of revenue, which does not apply in the other, except a transfer takes place to the local authority, when the provision applies.

The most important difference, however, is probably that Form I contains a section relating to the "transfer of powers," this section being omitted in Form II. It was the "Board of Trade" agreeing to insert this section at the desire of the local authorities that caused a mild rumpus in the camp of the supply companies. The local authorities were in some quarters judged guilty before they had committed a fault. They *might*, and this of course was as good as they would, obtain "provisional orders," with a mental or other reservation of intending immediately to transfer these orders to Tom, Dick, or Harry—pals of the wire-pullers. "Local authorities" in the abstract have neither body to be kicked nor soul to be saved, so there is no harm done in imputing to them possibilities of this kind. Of course no one believes it, but for certain purposes such accusations are useful, and at any rate it shows the local authorities that their actions will not escape notice. The section referring to transfer consists of seven clauses, the principal of which is the first, which reads that : "At any time after the commencement of this order the undertakers may, with the consent of the Board of Trade, from time to time, by deed to be approved by the Board of Trade, transfer their powers, duties, and liabilities to any company or person, subject to such exceptions and modifications (if any), and for such period and upon such terms as may be specified therein, and either as to the whole or any part or parts of the area of supply; and during the said period, but subject to the provisions of this order, such company or person shall, to the extent of the powers, duties, and liabilities so transferred, be the undertakers for the purposes of this order." The succeeding clauses refer to advertising the intention to transfer, renewing or continuing the transfer, revocation from the transferee, arbitration between transferer and transferee by the Board of Trade, and publication of the deed of transfer.

Of course these model forms will not be literally followed, but will serve to guide those who apply for provisional orders, and no doubt those who, through circumstances, are able to draft orders similar to those provided by the united wisdom of the officials will encounter least opposition to their proposals.

Notwithstanding all that has been said and done in respect to provisional orders, there is much to be made clear. In the first place, light will have to be thrown upon what may be termed vested interests. Let us take a case which may or may not arise. Clause 10, section 1, says: "Such energy shall be supplied only by means of some system which shall be approved by the Board of Trade, and subject to such regulations and conditions for securing the safety of the public, and for ensuring a proper and sufficient supply of energy, as the Board of Trade may from time to time impose." Which means, if it means anything, that the Board of Trade can, if so minded, be constantly interfering with the work. Everything may be satisfactorily passed to-day, but improvements may be made during the next twelve months that would suggest, were the installation carried out again, a modification here and a modification there. If, however, these modifications had to be carried out at the behest of the Board of Trade, it would be a ruinous state of things for the suppliers. Overhead wires may be safely allowed at one place but not at another. If allowed, and the postal authorities subsequently want to run new telegraph wires or telephone wires, which will be affected by the light wires, are the latter which exist, and have been passed by the Board of Trade, to give way, or to be treated as "vested interests," in possession and to remain? A further section, viz., section 3 of clause 10, speaks of telegraphic or telephonic circuits "intended to be used." That the electric light circuits will be constructed in a proper manner, with a full consideration of all existing and at the time intended circuits, is not questioned. The difficulty arises in consideration of circuits not thought of till months or years after the electric light wires are in place.

The full significance of many of the suggestions will not be realised till an attempt is made to put them into practice, when it may be found that the supply companies and their electrical engineers will have official difficulties to contend with which they have hardly anticipated at the present. However, the construction of the model orders has been undertaken in a careful and painstaking spirit, and has served to help the numerous authorities intending to undertake or sanction electrical supply in their procedure in an easier manner and on a surer basis than they could otherwise have hoped for.

TOO SOON.

There is a phase of "local authority" business which cannot well be admired. In some cases the local authority acts a little too precipitately, asks for tenders and proposals before it has settled the question of ways and means. No doubt it is advantageous and necessary when about to borrow money to know exactly how much is wanted, but suppose, after all the trouble and expense to those who prepare tenders, the money cannot be borrowed. Usually a man does not go to a tailor and ask him to undergo certain preliminary expenses, upon the understanding that an order is to be given only if a certain amount can be borrowed. The would-be purchaser should be pretty certain beforehand that the necessary funds will be forthcoming before seeking tenders. We have often pointed out that the cost of getting out plans and tenders is no small one. The total sum lost by the industry, when required to submit tenders and no business results, may often be reckoned by hundreds of pounds. While, then, there exists great willingness to tender, this anxiety will soon diminish if many cases arise where the initial effort to obtain business meets with no tangible result. There are cases both with local authorities and with private individuals when a craving for knowledge at other people's expense leads the authority or individual to seek for tenders, there never being any real intention of giving a contract. "We should like to know about how much it would cost"—and this desire to know may be satisfied at a very small expense to themselves, though the aggregate trouble and expense to those who furnish the information is not so small.

We are quite aware that a sportsman is not likely to kill much game without he puts shot as well as powder in his gun; and our grumble is likely for the present to end in smoke, because it deals with the abstract rather than the concrete. But, at the same time, it is necessary to mention and enforce this point, for recent events would seem to show that the tendency to ask for elaborate estimat the conditions are definitely ripe for it, has been allowed by overzealous or curious councilmen to put the whole of the electrical trade to great trouble without surety of result.

CORRESPONDENCE.

SHIP LIGHTING.

To the Editor of the Electrical Engineer.

Sir,—Travelling from Weymouth to Jersey a night or two ago by the very well found boats of the G.W.R., which are lighted throughout by incandescent lamps, I called the steward's attention to the lamp over my berth, which was not lighted. After trying the switch he said the lamp was broken. I asked whether he could not replace it by a fresh one, and was astonished to find he could not. Moreover, he added that the panel to which the lamp was affixed would have to come out before a new one could be substituted. Surely this is not businesslike. I do not pretend to know much about ship lighting where electricity is employed, but it seems to me that the steward ought to have a small stock of lamps by him, and be able, without much trouble, to unscrew a broken lamp and replace it at short notice. In this case, apparently, nothing could be done until Weymouth was reached again two days later.

As one who thoroughly appreciates the incandescent lamp on board ship, with its absence of smell and oscillation, I write to ask whether this unbusinesslike practice is the rule or the exception.—Yours, etc.,

A Traveller.

London, E.C., April 29, 1890.

ELECTRIC TRAMWAY DATA.

BY CARY T. HUTCHINSON, PH.D.

In this paper I purpose giving a short account of measurements made by me for the Sprague Company, and published with their consent, on several electric tramways. The measurements are chiefly electrical, but in some few cases engine tests were made. The data refers entirely to Sprague roads.

The same instruments were taken from place to place. They were two Weston voltmeters reading to 600 volts, two Weston ammeters reading to 100 amperes, a Wheatstone bridge set with 20 cells of battery, Tabor indicator, tachometer, speed indicator, etc. The electrical instruments had been calibrated just before starting out. I expected to have an ammeter reading to 300 at least, but it was not ready in time; hence for station readings the station ammeters had to be used.

All the roads are of the overhead, underrunning trolley system, with main conductors parallel to trolley wire along the sidewalk, connections being made at short intervals. The roads will be referred to as "A," "B," "C," "D," and "E."

A brief description of the character of the roads will be useful. Road A is divided into two parts by an "incline plane," about 1,000ft. long, having an inclination of about 35 per cent.; this incline is operated by a cable. The cars run through the lower part of the city, the business part, to the incline. Here they are lifted by a carriage on the incline to the top of the hills and continue on out into the residence portion of the city.

When these tests were made the incline was not working, owing to an accident some weeks before; hence the road was running in two separate sections, the lower and the upper. The lower end has about 1·03 mile and the upper 1·92 mile of double track. The rails are used here as return, there being no copper wire parallel with the track. This road is very uneven; there are very few level parts, and one grade as high as 15 per cent. for a short distance, and with almost all grades up to this.

POWER-HOUSE:

The power-house is at the head of the incline, nearly at the middle point of the line.

It contains two tubular boilers 16in. × 66in. with 54 flues; heating surface, 1,089 square feet; grate surface, 22·7 square feet. These are rated at 90 h.p. at 90lb. pressure. They supply steam to the engine used for the cable as well as for the dynamo engines.

Two engines, the first a Ball 16ft. × 16in., running at 240 revolutions, of 150 h.p.; the second a Greenwald (Brown) 18in. × 42in., running at 70 revolutions, of 150 h.p. Each of these engines drive two 50-kilowatt Edison shunt dynamos, 500 volts, at 845 revolutions. The slow-speed engine is belted to a countershaft; the high-speed directly to the dynamos. The Ball engine is held only as a reserve.

Usually, 20 cars are run, some with tow cars; but at this time only 10 were in use on account of the accident to the incline. The station is operated about 19 hours per day, the car mileage is 107 per day, and the duty of cars about 230 car hours per day.

Here the engines were indicated, and coal weighed, first using the Ball and then the Greenwald engine, reading of currents and E.M.F. being taken at the same time for a run of 8½ hours. The time was chosen so as to give as nearly as could be judged an average result. This is, the loads carried would average for the time about the same as if the tests had been taken for the entire day's run. Car readings and grade readings also were taken.

December 20. Greenwald engine. Readings taken from 9.30 a.m. to 6 p.m. = 8.5 hours. Current and E.M.F. readings every minute. Engine cards every half-hour.

Average (for time) number of cars	8·26
Mean e.h.p. from station readings..... ...	54·6
Mean e.h.p. from station readings, per car	6·6
Mean i.h.p.	67·2
Mean i.h.p., per car	8·1
Coal burned	2,283lb.
Coal burned per i.h.p., per hour	3·96lb.

December 22. Same arrangements, except Ball engine. Readings from 9.25 a.m. to 6 p.m. = 8·6 hours.

Same number of cars	8·26
Mean e.h.p. in station	56·2
Mean e.h.p. in station, per car	6·8
Mean i.h.p.	66·3
Mean i.h.p., per car	8·0
Coal burned	3,835lb.
Coal burned per i.h.p., per hour ...	4·98lb.

The average number of passengers per trip was not more than six to seven.

The friction card taken from the Ball engine turning both dynamos with the field circuits closed was 21·5 h.p.

READINGS ON GRADES:

No. 1. Mean grade 6 per cent., 965ft. long, with maximum of 10 per cent. for 80ft. and 15 per cent. for 90ft.

Speed, five miles per hour; 10 passengers.

Power required .... 21·2 h.p.

No. 2. Same repeated.

Power .... 23· h.p.

No. 3. Straight 4 per cent. grade for 2,472ft., perfectly regular.

Power .... 18 h.p

Insulation resistance 25,000 ohms for the entire system, about six miles of pole; this is ·15 megohm miles.

COST:

I am not at liberty to give the actual cost of operation for many reasons, but shall give here certain ratios which may be instructive.

By "cost per car mile" I mean the cost of "generating the power," plus cost of keeping cars and line in repair—*i.e.*, maintenance, plus cost of motormen and conductors, reduced to a car-mile basis. This excludes office expenses, rent, interest, depreciation other than repairs, salaries of clerical force, insurance, and, in fact, all general expenses of this nature. Cost of "generating power" or "central station" includes fuel, oil, waste, water, and attendance—*i.e.*, engineers, oilers, firemen, and all force about station.

Central Station Cost, Maintenance, Carmen = "*Cost*" *per Car Mile.*—The carmen form the very large part of this difference; other things are practically very small. Sometimes an employé, as an "electrician," works on the line and motors as well as in the power-house, so that, strictly, his time should be charged partly to one account and partly to another. This is not practicable, and so such a one is charged entirely to the power-house.

Maintenance includes the entire cost of keeping cars and line in repair—*i.e.*, materials and wages.

On road "A," then, putting the cost per car mile at 100, the distribution is as follows:

Carmen	71·5
Maintenance	1·8
Generating power	26·7
	100

Further the power-house item is divided into

Labour	20
Fuel	5·9
Oil, water, and waste	·8
Generating power total	26·7

ROAD "B."

This road is almost perfectly level; no grades worthy of the name exist. It is divided into two branches, which keep together for about 2·5 miles and then diverge. On one route there is about 5·5 miles and on the other about 4·94 of double track.

POWER-HOUSE:

The power-house is placed at almost the middle point of the line; the equipment consists of the following:

Boilers.—Seven tubular boilers, 18in. × 6in., 70 flues; heating surface, 1,488 square feet; grate surface, 33 square feet; rated 150 h.p.; 90lb. pressure. These boilers all have Murphy mechanical stokers.

Engines.—Three Armington and Sims, 18½in. × 18in., 200 revolutions; 250 h.p.; three A. and S., 14½in. × 15in., 260 revolutions; 125 h.p. Each engine is belted directly to two dynamos.

Dynamos.—Six 80-kilowatt, compound wound, with carbon brushes, two to each large engine. Six 40-kilowatt, shunt; two to each 125 h.p. engine. These last are to be compounded.

The station runs 24 hours per day. From 1 to 6 a.m. only two cars are on the line; the rest of the time the average is about 30. Motor cars draw tow cars about two-thirds of the time: for example, during November car No. 142 ran 3,098 miles, of which 2,247 miles was with a tow car; this was about the average. From this a car runs 103 miles a day; train 75 miles per day. Speed from six to nine miles per hour; average about eight.

CAR READINGS:

No. 1. Motor car with tow 16ft. cars. Round trip about 11 miles; 40 passengers; 30 per cent. of readings were zero—*i.e.*, current off—speed 7·2 miles per hour; mean starting current 95 amperes; maximum starting current 120 amperes.

Power on car .... 8·5 h.p.

No. 2. Same motor car, but no tow; round trip 11·7 miles; speed 7·6 per hour; 18 passengers; 40 stops; 33 per cent. of readings, zero; mean starting current, 80 amperes; maximum, 100 amperes.

Power on car .... 6·17 h.p.

From tests made by the company's engineers, engine cards and electrical readings being taken every half hour, they find:

Mean average e.h.p.	276
Mean average i.h.p.	360
Ratio $\frac{\text{E.H.P.}}{\text{I.H.P.}}$	77 per cent.

The number of cars running at the different hours of the day was not noted by them.

The insulation resistance was 6·9 megohm-miles for about 15 miles of poles; separate feeder circuits gave 2·9, 1·4, and 10 megohm-miles; the low figure was for a line running through trees.

COST:

Since motor power cars tow a large part of the time there can be no reduction to a motor car mile, or to a train mile simply; but,

Average number of motor cars per day	23·4
Train mileage	75
Motor car mileage	103

The motors tow for 73 per cent. of the entire time this is:

23·4 × ·73, average number of trains	17·1
23·4 × ·27, average number of motors alone	6·3

Further, if X be the total cost per train mile, and Y be the total cost per motor car mile (without tow), then $\frac{17{\cdot}1\,X + 6{\cdot}3\,Y}{24{\cdot}3}$ is the cost per car mile run by the motor, regardless of towing.

This figure will be meant when "cost per car mile" simply is used, and is to be distinguished from "cost per train mile" and "cost per motor car mile."

If the "cost per car mile" be 100, then the distribution is as follows:

Carmen	73·7
Maintenance	14
Generating power	12·3
Total	100

And of the cost of the power-house:

Labour	6·4
Fuel	4·2
Oil, waste, water, etc.	1·7
Generating power, total	12·3

RATIO OF COST ON TRAIN TO COST ON MOTOR CAR:

The cost of conductors and motor men is in the ratio, $\frac{\text{Train}}{\text{Motor car}} = 1{\cdot}47$; this item is 73·7 per cent. of the total.

The power required for a train is, say, 1·4 times that for the motor car; but attendance at the power-house is not increased, and oil is increased inappreciably. About the only increase is in fuel, and fuel constitutes about ⅓ of the power-house expense.

Therefore, the ratio of the cost of power, $\frac{\text{Train}}{\text{Motor}} = (\frac{2}{3} + \frac{1}{3} \times 1{\cdot}4) = 1{\cdot}13$. This item is 12·3 per cent. of the total. Repairs are alike for both, and are 14 per cent. of the total. We have then:

$$\text{Ratio of total cost, } \frac{\text{Train}}{\text{Motor car}} = {\cdot}74 \times 1{\cdot}47 + 1{\cdot}13 \times {\cdot}12 + {\cdot}14.$$

That is, $\frac{X}{Y} = 1{\cdot}37$.

ROAD "C."

The road here is entirely single track with turnouts about four miles long. There are many grades, some of 7 or 8 per cent.; in fact, the entire road is up and down hill. The road is in the form of an L, with the power-house at the junction. One branch has a return copper conductor; the other uses the rails connected at intervals to buried earth plates for the return.

POWER-HOUSE:

Boilers.—Two tubular, 18ft. × 6ft.; 68 4in. tubes. Heating surface, 1,450 square feet; grate surface, 38 square feet; rated at 150 h.p.

Engines.—Three Ball, 16in. × 16in., 240 revolutions, 150 h.p., belted directly to dynamos.

Dynamos.—Six 50-kilowatt Edison; four are shunt, but are soon to be compounded.

Nine or 10 cars run constantly, and both boilers are used with two engines and four dynamos. They burn about 6·7 tons of coal per day of 16 hours. Round trip about eight miles. Car mileage 105 per day.

Car Readings.—Readings every 30 seconds; number of passengers, 18; number of stops, 30; mean starting current, 47 amperes; power, 7·74 h.p.

POWER ON GRADES:

1·38 per cent.	650ft.	10 h.p.	Aver. 11·9
1·4 „	900ft.	12·4	
1·5 „	1,600ft.	13·4	

3·25 per cent.	800ft.	15·	
3·8 „	800ft.	17·3	Aver. 18·5
3·8 „	1,200ft.	19·8	

The load in all cases was about 9,000lb. to 10,000lb., and the speed from seven miles per hour to five on grades.

The insulation resistance was 3·2 megohm-miles, with about 8 miles of poles. The resistance of the copper overhead conductor and return underground by copper wire and rails of the section fitted this way is 2·25 ohms.

Calculated resistance of outgoing circuit	1·38 ohms.
Return	·87 „

The distance was two miles. This was the only place at which I succeeded in making this measurement. There was always some interference by extraneous currents, giving large deflection when battery circuit was open.

I have not been able to get the cost of operating this line.

Road "D."

The town here is entirely flat. There is a main line with six branches tapping the main line at various points of its length and running to both sides of it. The power-house is at one end of the line.

POWER-HOUSE :

Boilers.—Two tubular 78in. × 16ft. ; 1,042in. tubes. Heating surface, 1,013 square feet. Grate surface, 33 square feet.

Engines.—Two Ball, 16in. × 16in. ; 250 revolutions ; 150 h.p.

Dynamos.—Four 50-kilowatt Edison shunt-wound.

About 17 cars are equipped, and 14 of them run for 18 hours ; one engine and one pair of dynamos are used from 6 a.m. to 3 p.m., the other set from 3 p.m. to 12 midnight.

The speed was about six miles per hour ; there was no towing ; the car mileage is 105 per day.

Car Readings.—Readings every 30 seconds ; eight passengers, 30 stops ; mean starting current, 75 amperes ; power 8·62 h.p.

GRADE READINGS :

Flying start, 9·5 per cent. for 775ft.	23·7 h.p.
Still start, 9·5 per cent. for 775ft.	25·7
Load about	9,000lb.

ENGINE TESTS :

Cards were taken at half-hour intervals from 2 to 7 p.m., to include the heavy load of the evening.

Maximum card	124 i.h.p.
Minimum card	44 „
Mean for five hours	86·4 „
Friction of engine and two dynamos, circuits open	13·4 „
The above gives :	
Average power per car	6·17 i.h.p.

The load here does not vary so much as usual owing to the large number of cars run to the engine. I have seen the line current as high as 350 amperes—*i.e.*, a 150 h.p. engine doing 215 h.p. of electrical work, to say nothing of friction load.

The insulation was about 4 megohm-miles.

COST :

Taking the cost per car mile as	100
we have the following :	
Carmen	67
Maintenance	18
Generating power	15
	100
And of the power-house expenses :	
Labour	7·3
Fuel	5·2
Oil, waste, etc.	2·5
Generating power, total	15·0

Road "E."

There are no grades on the main line of this road. It has about 2·3 miles of double track. Eight motor cars run on an average ; but for about an hour in the afternoon 10 motor cars run, six of them with tow cars. The car mileage is 110.

POWER-HOUSE :

Two Babcock and Wilcox 150-h.p. boilers, 64 tubes, 4in. by 18′ ; heating surface, 1,404 square feet ; grate surface, 35 square feet. There are two 18in. by 42in. Corliss condensing engines of 150 h.p., and two 80-kilowatt shunt-wound Edison dynamos.

The engines are belted to a countershaft fitted with clutches so that either or both engines can run either or both dynamos. Usually one engine is used with two dynamos turning, only one supplying current, but during the time of heaviest load both dynamos are in circuit. Neither ground wire nor earth plates is used ; the return is made entirely by the rails connected to each other by copper bonds.

Here coal was measured, engine cards taken every 15 minutes, and station readings every 2½ minutes from 5.40 a.m. to 11.30 p.m.—that is, for the entire day's run. The results are :

Average i.h.p.	66·5
Average e.h.p.	52·
Average number of cars	8·
I.H.P., per car	8·3
E.H.P., per car	6·5
Shafting with two dynamos, circuits open, but fields made	24·6 h.p.
Shafting alone	15·6 „
Leaving for one dynamo	4·5 „
Time of test, 17·7 hours.	
Coal	5,350lb.
Coal per i.h.p., per hour	4·54 „
Coal per square foot grate per hour	8·6 „

CAR READINGS :

Cars all 16ft. ; motor car weighs nearly 10,000lb. ; trail car, 5,300.

Without trail car : About seven stops, 14 passengers.

Mean starting current, 75 amperes ; 33 per cent. of the readings zeros ; e.h.p., 8·1.

With trail car : About nine stops, 20 passengers.

Mean starting current, 80 amperes ; 30 per cent. of the readings zeros ; e.h.p., 10·3.

Ratio of power, train to motor car, 1·27.

Both of the above are the mean of a number of trips.

The insulation was ·5 meghom-miles for eight miles of poles.

COST :

The amount of towing is inconsiderable, only seven car hours out of 141, so that it is taken into account only in the wages of carmen.

Taking the cost per car mile as equal to 100, we have	
Carmen	65·5
Maintenance	12·7
Generating power	21·8
	100
And of the power-house cost :	
Labour	10
Fuel	10
Oil, waste, etc.	1·8
Generating power, total	21·8

(*To be concluded.*)

PROVISIONAL ORDER.

FORM II.—UNDERTAKERS BEING A COMPANY OR PERSON.

PRELIMINARY.

1. This order may be cited as the ——— Electric Lighting Order 1890.

2. This order is to be read and construed subject in all respects to the provisions of the Electric Lighting Acts, 1882 and 1888, and of any other Acts or parts of Acts incorporated therewith, which said Acts and parts of Acts are in this order collectively referred to as "the principal Act," and the several words, terms, and expressions to which by the principal Act meanings are assigned, shall have in this order the same respective meanings, provided that in this order :

The expression "energy" shall mean electrical energy, and for the purposes of applying the provisions of the principal Act to this order electrical energy shall be deemed to be an agency within the meaning of electricity as defined in the Electric Lighting Act, 1882;

The expression "power" shall mean electrical power or the rate per unit of time at which energy is supplied;

The expression "main" shall mean any electric line which may be laid down by the undertakers in any street or public place, and through which energy may be supplied or intended to be supplied by the undertakers for the purposes of general supply;

The expression "service line" shall mean any electric line through which energy may be supplied or intended to be supplied by the undertakers to a consumer either from any main or directly from the premises of the undertakers;

The expression "distributing main" shall mean the portion of any main which is used for the purpose of giving origin to service lines for the purposes of general supply;

The expression "general supply" shall mean the general supply of energy to ordinary consumers, and, unless otherwise specially agreed with the local authority, to the public lamps, but shall not include the supply of energy to any one or more particular consumers under special agreement;

The expression "area of supply" shall mean the area within which the undertakers are, for the time being, authorised to supply energy under the provisions of this order;

The expression "consumer" shall mean any body or person supplied or entitled to be supplied with energy by the undertakers.

The expression "consumer's terminals" shall mean the ends of the electric lines situate upon any consumer's premises and belonging to him, at which the supply of energy is delivered from the service lines.

The expressions "first schedule," "second schedule," "third schedule," and "fourth schedule" shall mean the first, second, third, and fourth schedules to this order annexed respectively.

The expression "deposited map" shall mean the map of the area of supply deposited at the Board of Trade by the undertakers together with this order, and signed by an assistant secretary to the Board of Trade.

3. This order shall come into force and have effect upon the day when the Act confirming this order is passed, which date is in this order referred to as "the commencement of this order."

Address and Description of the Undertakers.

4. The undertakers for the purpose of this order are, being a company registered under the Companies' Acts, 1862 to 1886, with limited liability, and having its registered offices at ——, and having its capital divided into —— shares of £— each.[*]

Provided that if the undertaking or any part thereof is at any time purchased by the local authority in accordance with the provisions of this order, or of the principal Act, such local authority shall from the date of such purchase be the undertakers in relation to such undertaking or part thereof for the purposes of this order in lieu of the company above mentioned.

The undertakers shall not purchase or acquire the undertaking of or associate themselves with any other company or person supplying energy under any license, provisional order, or special Act, unless the undertakers are authorised by Parliament to do so.

If in contravention of this section the undertakers purchase or acquire any such undertaking or associate themselves with such other company or person the Board of Trade may, if they think fit, revoke this order upon such terms as they may think just.

Area of Supply.

5. Subject to the provisions of this order, the area of supply shall be the whole of the area included in the first schedule, which said area is more particularly delineated upon the deposited map, and thereon coloured red.

6. The undertakers shall not at any time after the commencement of this order supply energy, or (except for the purposes of this order) erect or lay down any electric lines or works beyond the area of supply, otherwise than under the authority of Parliament, or under a license granted by the Board of Trade.

If the undertakers supply energy or erect or lay down electric lines or works in contravention of this section, the Board of Trade may revoke this order on such terms as they may think just.

Security and Accounts.

7. The undertakers, within a period of six months after the commencement of this order and before exercising any of the powers by this order conferred on them in relation to the execution of works, shall show to the satisfaction of the Board of Trade that they are in a position fully and efficiently to discharge the duties and obligations imposed upon them by this order throughout the area of supply.

The undertakers shall also, within six months after the commencement of this order, or such extended period as may be approved by the Board of Trade, and before exercising any of the powers conferred on them in relation to the execution of works, deposit or secure to the satisfaction of the Board of Trade a sum of —— pounds.[†]

If within any such period as aforesaid the undertakers fail to show to the satisfaction of the Board of Trade that they are in such a position as above mentioned, or fail to deposit or secure such sum as aforesaid, the Board of Trade may, after considering any representations which the local authority may make, revoke this order as to the whole, or, with the consent of the undertakers, any part of thearea of supply, upon such terms as they may think just.

The said sum deposited or secured by the undertakers under the provisions of this section shall be repaid or released to them from to time in equal moieties, when and so soon as it may be certified by an inspector, to be appointed by the Board of Trade, that amounts equal to the sums so to be repaid or released have been expended by the undertakers upon works executed for the purposes of the undertaking, or that distributing mains have been duly laid down in accordance with the provisions of this order in every street, or part of a street, specified in that behalf in the second schedule, or at such earlier dates and by such instalments as may from time to time be approved by the Board of Trade.

8. The undertakers shall, except with the special approval of the Board of Trade, to be previously given (after consideration of any representations which the local authority may make), at all times keep accounts of the capital employed for the purposes of the undertaking distinct from the accounts kept by them in respect of any other undertaking or business.

9. The annual statement of accounts of the undertaking, before being published as provided by section 9 of the Electric Lighting Act, 1882, shall, so long as the local authority are not the undertakers, be examined and audited by such competent and impartial person as the County Council[*] shall from time to time appoint, and the remuneration of the auditor shall be such as the County Council shall from time to time direct, and the same and all expenses incurred by him in or about the execution of his duties, to such an amount as the County Council shall approve, shall be paid by the undertakers on demand, and shall be recoverable summarily as a civil debt.

The undertakers shall give to the auditor, his clerks and assistants, access to such of the books and documents relating to the undertaking as shall be necessary for the purposes of the audit, and shall, when required, furnish to him and them all vouchers and information requisite for such purpose, and shall afford to him and them all facilities for the proper execution of his and their duty.

The County Council may from time to time make and vary regulations prescribing the times at and the mode in which such audit shall be made and conducted, or otherwise, for the purpose of giving effect to the provisions of this section.

Nature and Mode of Supply.

10. Subject to the provisions of this order and the principal Act, the undertakers may supply energy within the area of supply for all public and private purposes as defined by the said Act, provided as follows:

1. Such energy shall be supplied only by means of some system which shall be approved of by the Board of Trade, and subject to such regulations and conditions for securing the safety of the public, and for ensuring a proper and sufficient supply of energy as the Board of Trade may from time to time impose; and

2. The undertakers shall not permit any part of any circuit to be connected with earth except so far as may be necessary for carrying out the provisions of any such regulations or conditions as aforesaid, unless such connection is for the time being approved of by the Board of Trade, with the concurrence of the Postmaster-General, and is made in accordance with the conditions, if any, of such approval; and

3. The undertakers shall construct their mains and other works of all descriptions, and shall work their undertaking in all respects with due regard to other electric circuits from time to time used or intended to be used, for the purpose of telegraphic, telephonic, or electric signalling communication, or the currents in such circuits, and shall use every reasonable means in the construction of their mains and other works of all descriptions, and the working of their undertaking, to prevent injurious affection whether by induction or otherwise to such electric circuits, or the currents in such circuits. If any question arises as to whether the undertakers have constructed their mains or other works, or worked their undertaking, in contravention of this sub-section, such question shall be determined by arbitration, and the undertakers shall be bound to make any alterations in or additions to their system which may be directed by the arbitrator.

Provided that nothing in this sub-section contained shall be held to deprive the owners of such electric circuits of any existing rights to proceed against the undertakers by indictment, action, or otherwise in relation to any of the matters aforesaid.

Works

11. Subject to the provisions of this order and the principal Act, the undertakers may from time to time exercise all or any of the powers conferred on them by this order and the principal Act, and may break up such streets, not repairable by the local authority, and such railways and tramways (if any)[†] as are specified in the third schedule, so far as such streets, railways, and tramways may for the time being be included in the area of supply, and be, or be upon, land dedicated to public use. Provided, however, as respects any such railway, that the powers hereby granted shall extend only to such parts thereof as pass across or along any highway on the level.

Nothing in this order shall authorise or empower the undertakers to break up or interfere with any street or part of a street not repairable by the local authority or any railway or tramway, except such streets, railways, or tramways (if any), or such parts thereof, as are specified in the said schedule, without the consent of the authority, company, or person by whom such street, railway, or tramway is repairable.

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[*] Or otherwise describe the company or person.

[†] Where two or more local authorities' districts are involved, the deposit or security may be required to be made or given in respect of such districts severally; and in such case will be repaid or released separately as to each district.

[*] Where the area of supply is a county borough, or part thereof, the auditor will be appointed by the Board of Trade; in Scotland, he will be appointed by the sheriff.

[†] Where special powers as to such streets, railways, or tramways are not taken, the third schedule will be filled in with the word "None" as to heads (*a*), (*b*) or (*c*) therein appearing, as the case may be

12. Subject to the provisions of this order and the principal Act, and any regulations made under this order, the undertakers may also from time to time construct in any street such boxes as may be necessary for purposes in connection with the supply of energy, including apparatus for the proper ventilation of such boxes, provided that no such box shall be placed above ground except with the consent of the local authority.

Every such box shall be for the exclusive use of the undertakers and under their sole control, except so far as the Board of Trade may otherwise order, and shall be used by the undertakers only for the purpose of leading off service lines and other distributing conductors, or for examining, testing, regulating, measuring, directing, or controlling the supply of energy, or for examining or testing the condition of the mains or other portions of the works, or for other like purposes connected with the undertaking; and the undertakers may place therein meters, switches, and any other suitable and proper apparatus for any of the above purposes.

Every such box, including the upper surface or covering thereof, shall be constructed of such materials, and shall be constructed and maintained by the undertakers in such manner as not to be a source of danger whether by reason of inequality of surface or otherwise.

The local authority may, with the approval of the Board of Trade, prescribe the hours during which the undertakers are to have access to such boxes, and if the undertakers, during any hours not so prescribed, remove or displace, or keep removed or displaced, the upper surface or covering of any box without the consent of the local authority, they shall be liable to a penalty not exceeding £5 for every such offence, and in the case of a continuing offence, to a further penalty of £5 for every day during which such offence continues: Provided that the undertakers shall not be subject to any such penalties as aforesaid if the court having cognisance of the case shall be of opinion that the case was one of emergency, and that the undertakers complied with the requirements of this section so far as was reasonable under the circumstances.

13. The undertakers shall not, without the express consent of the local authority, place any electric line above ground, along, over, or across any street or public place, or (except in the case of any electric line so placed before the commencement of this order and during the time limited by this section for the removal thereof) supply energy by means of any electric line so placed.

Where any electric lines of the undertakers have been placed above ground as aforesaid before the commencement of this order they shall be removed by the undertakers within a period of one year after such commencement.

If the undertakers place or fail to remove any electric lines in contravention of this section they shall be liable to a penalty not exceeding £10 for every such offence, and in the case of a continuing offence to a further penalty not exceeding £5 for every day after the first day during which such offence continues, and any court of summary jurisdiction on complaint made may make an order authorising the removal of any such electric line by such person and on such terms as they may think fit.

14. Where the exercise of any of the powers of the undertakers in relation to the execution of any works (including the construction of boxes) will involve the placing of any works in, under, along, or across any street or public bridge, the following provisions shall have effect:

(*a.*) One month before commencing the execution of such works (not being the repairs, renewals or amendments of existing works, of which the character and position are not altered), the undertakers shall serve a notice upon the Postmaster-General and the local authority describing the proposed works, together with a plan of the works, showing the mode and position in which such works are intended to be executed, and the manner in which it is intended that such street or bridge, or any sewer, drain, or tunnel therein or thereunder, is to be interfered with, and shall, upon being required to do so by the Postmaster-General or the local authority from time to time give him or them any such further information in relation thereto as he or they may desire. In calculating the above-mentioned period of one month, no part of the month of August shall be included.

(*b.*) The Postmaster-General or the local authority may in his or their discretion approve of any such works or plan, subject to such amendments or conditions as may seem fit, or may disapprove the same, and may give notice of such approval or disapproval to the undertakers.

(*c.*) Where the Postmaster-General or the local authority approve any such works or plan, subject to any amendments or conditions with which the undertakers are dissatisfied or disapprove of any such works or plan, the undertakers may appeal to the Board of Trade, and the Board of Trade may enquire into the matter, and allow or disallow such appeal, and approve any such works or plan, subject to such amendments or conditions as may seem fit, or may disapprove the same.

(*d.*) If the Postmaster-General or the local authority fail to give any such notice of approval or disapproval to the undertakers within one month after the service of the notice upon them, he or they shall be deemed to have approved such works and plan.

(*e.*) Notwithstanding anything in this order or the principal Act, the undertakers shall not be entitled to execute any such works as above specified, except so far as the same may be of a description and in accordance with a plan which has been approved, or is to be deemed to have been approved, by the Postmaster-General and the local authority, or by the Board of Trade, as above mentioned, but where any such works, description, and plan are so approved, or to be deemed to be approved, the undertakers may cause such works to be executed in accordance with such description and plan, subject in all respects to the provisions of this order and of the principal Act.

(*f.*) Where it appears to the Postmaster General that any work of the undertakers is intended to be executed in such proximity to a telegraphic line of the Postmaster-General that such telegraphic line is likely in his opinion to be damaged or injured during the construction of such work, the undertakers shall pay to the Postmaster-General such reasonable expenses as he may incur in inspecting the execution of such work.

(*g.*) If the undertakers make default in complying with any of the requirements or restrictions of this section they shall (in addition to any other compensation which they may be liable to make under the provisions of this order or the principal Act) make full compensation to the Postmaster-General and the local authority for any loss or damage which he or they may incur by reason thereof, and in addition thereto they shall be liable to a penalty not exceeding £10 for every such default, and in the case of a continuing offence to a further penalty not exceeding £5 for every day after the first day during which such default continues: Provided that the undertakers shall not be subject to any such penalties as aforesaid if the court having cognisance of the case shall be of opinion that the case was one of emergency, and that the undertakers complied with the requirements of this section so far as was reasonable under the circumstances.

For the purpose of this order the word "plan" shall mean a plan drawn to a horizontal scale of at least 1in. to 88ft., and where possible a section drawn to the same horizontal scale as the plan, and to a vertical scale of at least 1in. to 11ft., with such detail plan and sections as may be necessary.

15. Where the exercise of the powers of the undertakers in relation to the execution of any works will involve the placing of any works in, under, along, or across any street or part of a street not repairable by the local authority or over or under any railway, tramway, or canal, the following provisions shall have effect, unless otherwise agreed between the parties interested:

(*a.*) One month before commencing the execution of any such works (not being the repairs, renewals, or amendments of existing works of which the character and position are not altered) the undertakers shall, in addition to any other notices which they may be required to give under this order or the principal Act, serve a notice upon the body or person liable to repair such street or part of a street, or the body or person for the time being entitled to work such railway or tramway, or the owners of such canal (as the case may be), in this section referred to as the "owners," describing the proposed works, and stating the amount of compensation (if any) proposed to be made in respect thereof, and the manner in which such compensation is proposed to be paid or secured, together with a plan of the works showing the mode and position in which such works are intended to be executed and placed, and shall, upon being required to do so by any such owners, from time to time give them any such further information in relation thereto as they may desire.

(*b.*) Every such notice shall contain a reference to this section, and direct the attention of the owners to whom it is given to the provisions thereof.

(*c.*) Within three weeks after the service of any such notice and plan upon any owners, such owners may, if they think fit, serve a requisition upon the undertakers requiring that any question in relation to such works, and any other question arising upon such notice or plan as aforesaid, shall be settled by arbitration, and thereupon such question, unless settled by agreement, shall be settled by arbitration accordingly.

(*d.*) In settling any question under this section an arbitrator shall have regard to any duties or obligations which the owners may be under in respect of such street, railway, tramway, or canal, and may, if he thinks fit, require the undertakers to execute any temporary or other works so as to avoid any interference with any traffic, so far as may be possible.

(*e.*) Where no such requisition as in this section mentioned is served upon the undertakers, or where, after any such requisition has been served upon them, any question required to be settled by arbitration has been so settled, the undertakers may, upon paying or securing any compensation which they may be required to pay or secure in the manner proposed by them or settled by arbitration as aforesaid, cause to be executed the works specified in such notice and plan as aforesaid, and may from time to time repair, renew, and amend the same (provided that their character and position are not altered), but subject in all respects to the provisions of this order and the principal Act, and only in accordance with the notice and plan so served by them as aforesaid, or such modifications thereof respectively as may have been settled by arbitration as hereinbefore mentioned, or as may be agreed upon between the parties.

(*f.*) All works to be executed by the undertakers under this section shall be carried out to the reasonable satisfaction of the owners, who shall have the right to be present during the execution of such works.

(*g.*) Where the repair, renewal, or amendment of any existing works, of which the character or position are not altered, will involve any interference with the working of or traffic on any tramway over or under which such works have been placed, the undertakers shall, unless otherwise agreed between the parties, or in cases of emergency, give to the owners not less than 24 hours' notice before commencing to effect such repair, renewal, or amendment, and the owners shall be entitled by their officer to superintend the work, and the undertakers shall conform to such reasonable requirements as may from time to time be made by the owners or such officer.

(*h.*) If the undertakers make default in complying with any of the requirements or restrictions of this section they shall (in addition to any other compensation which they may be liable to make under the provisions of this order or the principal Act) make full compensation to the owners affected thereby for any loss or damage which they may incur by reason thereof, and in addition thereto they shall be liable to a penalty not exceeding £10 for every such default, and in the case of a continuing offence to a further penalty not exceeding £5 for every day after the first day during which such default continues: Provided that the undertakers shall not be subject to any such penalties as aforesaid if the court having cognisance of the case shall be of opinion that the case was one of emergency, and that the undertakers complied with the requirements of this section so far as was reasonable under the circumstances.

16. The local authority, and any body or person for the time being liable to repair any street or part of a street, or entitled to work any railway or tramway which the undertakers may be empowered to break up for the purposes of this order, may, if they think fit, from time to time serve a notice upon the undertakers stating that they desire to exercise or discharge all or any part of any of the powers or duties of the undertakers as therein specified in relation to the breaking up, filling in, reinstating, or making good any streets, bridges, sewers, drains, tunnels, or other works vested in or under the control or management of the local authority, or other body or person as the case may be, and may from time to time amend or revoke any such notice by another notice similarly served. Where the local authority, or any such body or person as aforesaid (in this section referred to as "the givers of the notice") have given notice that they desire to exercise or discharge any such specified powers and duties of the undertakers, then so long as such notice remains in force the following provisions shall have effect, unless otherwise agreed between the parties interested:

(*a.*) The undertakers shall not be entitled to proceed themselves to exercise or discharge any such specified powers or duties as aforesaid, except where they have required the givers of the notice to exercise or discharge such powers or duties, and the givers of the notice have refused or neglected to comply with such requisition, as hereinafter provided, or in cases of emergency.

(*b.*) In addition to any other notices which they may be required to give under the provisions of this order or the principal Act, the undertakers shall, not more than four days and not less than two days before the exercise or discharge of any such powers or duties so specified as aforesaid is required to be commenced, serve a requisition upon the givers of the notice stating the time when such exercise or discharge is required to be commenced, and the manner in which any such powers or duties are required to be exercised or discharged.

(*c.*) Upon receipt of any such requisition as last aforesaid, the givers of the notice may proceed to exercise or discharge any such powers or duties as required by the undertakers subject to the like restrictions and conditions as the undertakers would themselves be subject to in such exercise or discharge so far as the same may be applicable.

(*d.*) If the givers of the notice decline, or for 24 hours after the time when any such exercise or discharge of any powers or duties is by any requisition required to be commenced, neglect to comply with such requisition, the undertakers may themselves proceed to exercise or discharge the powers or duties therein specified in like manner as they might have done if such notice as aforesaid had not been given to them by the givers of the notice.

(*e.*) In any case of emergency the undertakers may themselves proceed to at once exercise or discharge so much of any such specified powers or duties as aforesaid as may be necessary for the actual remedying of any defect from which the emergency arises without serving any requisition on the givers of the notice; but in such case the undertakers shall, within 12 hours after they begin to exercise or discharge such powers or duties as aforesaid, give information thereof in writing to the givers of the notice.

(*f.*) If the undertakers exercise or discharge any such specified powers or duties as aforesaid otherwise than in accordance with the provisions of this section, they shall be liable to a penalty not exceeding £10 for every such offence, and in the case of a continuing offence to a further penalty not exceeding £5 for every day after the first day during which such offence continues: Provided that the undertakers shall not be subject to any such penalties as aforesaid if the court having cognisance of the case shall be of opinion that the case was one of emergency, and that the undertakers complied with the requirements of this section so far as was reasonable under the circumstances.

(*g.*) All expenses properly incurred by the givers of the notice in complying with any requisition of the undertakers under this section shall be repaid to them by the undertakers, and may be recovered summarily before a court of summary jurisdiction, who shall have power to determine the amount thereof.

(*h.*) The givers of the notice may from time to time, if they think fit, require the undertakers to give them such security for the repayment to them of any expenses incurred or to be incurred by them under this section as may be determined in manner provided by this order. If the undertakers fail to give any such security within seven days after being required to do so, or in case of difference after such difference has been determined by a court of summary jurisdiction, they shall not be entitled to serve any further requisition upon such givers of the notice requiring them to exercise or discharge any powers or duties under this section until such security has been duly given.

Provided that nothing in this or the last preceding section shall in any way affect the rights of the undertakers to exercise or discharge any powers or duties conferred or imposed upon them by this order or the principal Act in relation to the execution of any works beyond the actual breaking up, filling in, reinstating, or making good any such street or part of a street, or any such bridges, sewers, drains, tunnels, or other works, or railway or tramway as in these sections respectively mentioned.

17. The undertakers may from time to time alter the position of any pipes (not forming part of any sewer of the local authority) or any wires being under any street or place authorised to be broken up by them, which may interfere with the exercise of their powers under the principal Act or this order; any body or person may in like manner alter the position of any electric lines or works of the undertakers, being under any such street or place as aforesaid, which may interfere with the lawful exercise of any powers vested in such body or person in relation to such street or place, subject to the following provisions, unless otherwise agreed between the parties interested:

(*a.*) One month before commencing any such alteration the undertakers, or such body or person (as the case may be), in this section referred to as "the operators," shall serve a notice upon the body or person for the time being entitled to such pipes, wires, electric lines, or works (as the case may be), in this section referred to as "the owners," describing the proposed alteration, and stating the amount of compensation (if any) proposed to be made in respect thereof, and the manner in which such compensation (if any) is proposed to be paid or secured, together with a plan showing the manner in which it is intended that such alterations shall be made, and shall, upon being required to do so by any such owners, from time to time give them any such further information in relation thereto as they may desire.

(*b.*) Within three weeks after the service of any such notice and plan upon any owners, such owners may, if they think fit, serve a requisition upon the operators, requiring that any question in relation to such works, or any other question arising upon such notice or plan as aforesaid, shall be settled by arbitration, and thereupon such question, unless settled by agreement, shall be settled by arbitration accordingly.

(*c.*) In settling any question under this section an arbitrator shall have regard to any duties or obligations which the owners may be under in respect of such pipes, wires, electric lines, or works, and may, if he thinks fit, require the operators to execute any temporary or other works, so as to avoid interference with any purpose for which such pipes, wires, electric lines, or works are used so far as may be possible.

(*d.*) Where no such requisition as in this section mentioned is served upon the operators, the owners shall be held to have agreed to the notice or plan served on them as aforesaid, and in such case, or where, after any such requisition has been served upon them, any question required to be settled by arbitration has been so settled, the operators, upon paying or securing any compensation which they may be required to pay or secure in the manner proposed by them or settled by arbitration as aforesaid, may cause the alterations specified in such notice and plan as aforesaid to be made, but subject in all respects to the provisions of this order and the principal Act, and only in accordance with the notice and plan so served by them as aforesaid, or such modifications thereof respectively as may have been settled by arbitration as hereinbefore mentioned, or as may be agreed upon between the parties.

(*e.*) At any time before any operators are entitled to commence any such alterations as aforesaid, the owners may serve a statement upon the operators stating that they desire to execute such alterations themselves, and where any such statement has been served upon the operators, they shall not be entitled to proceed themselves to execute such alterations, except where they have notified to such owners that they require them to execute such alterations, and such owners have refused or neglected to comply with such notification as hereinafter provided.

(*f.*) Where any such statement as last aforesaid has been served upon the operators, they shall, not more than 48 hours and not less than 24 hours before the execution of such alterations is required to be commenced, serve a notification upon the owners, stating the time when such alterations are required to be commenced, and the manner in which such alterations are required to be made.

(*g.*) Upon receipt of any such notification as last aforesaid, the owners may proceed to execute such alterations as required by the operators, subject to the like restrictions and conditions as the operators would themselves be subject to in executing such alterations, so far as the same may be applicable.

(*h.*) If the owners decline, or for 24 hours after the time when any such alterations are required to be commenced, neglect to comply with such notification, the operators may themselves proceed to execute such alterations in like manner as they might have done if no such statement as aforesaid had been served upon them.

(*i.*) All expenses properly incurred by any owners in complying with any notification of any operators under the last preceding subsections shall be repaid to them by such operators, and may be recovered summarily before a court of summary jurisdiction, who shall have power to determine the amount thereof.

(*j.*) Any owners may, if they think fit, by any statement served by them upon any operators under this section, require the operators to give them such security for the repayment to them of any expenses to be incurred by them in executing any alterations as above mentioned as may be determined in manner provided by this order, and where any operators have been so required to give security, they shall not be entitled to serve a notification upon the owners requiring them to execute such alterations until such security has been duly given.

(*k.*) If the operators make default in complying with any of the requirements or restrictions of this section they shall (in addition to any other compensation which they may be liable to make under the provisions of this order or the principal Act) make full compensation to the owners affected thereby for any loss, damage, or penalty which they may incur by reason thereof, and in addition thereto they shall be liable to a penalty not exceeding £10 for every such default, and in the case of a continuing offence to a further penalty not exceeding £5 for every day after the first day during which such default continues: Provided that the operators shall not be subject to any such additional penalties as aforesaid if the court having cognisance of the case shall be of opinion that the case was one of emergency, and that the operators complied with the requirements of this section so far as was reasonable under the circumstances.

(*To be continued*).

COMPANIES' MEETINGS.

ORIENTAL TELEPHONE COMPANY, LIMITED.

The tenth ordinary general meeting of the shareholders of this Company was held on Tuesday, at the City Terminus Hotel, Cannon-street, E.C., under the presidency of Mr. William Addison.

The **Chairman**, in moving the adoption of the report, said that the Company was making steady progress, and was greatly strengthening its financial position. In 1884 the reserve, which had at the previous two years stood at £7,000, was, in order to meet exigencies, transferred to the credit of profit and loss account, and since then until last year no reserve fund had existed. The Directors, however, felt that as soon as they were in a position to do so, a new reserve fund should be formed, and, in pursuance of that purpose, they placed £2,500 to reserve last year, and they had added £2,000 more this year. Their reserve now stood at £4,500, as against £7,000 at the beginning of 1884. The Board has written off £500 for depreciation of stores at branches, principally at Mauritius, which had been done in order that that asset should be of the value they assigned to it in the balance-sheet. In China the business was steadily improving, and he confidently looked forward to the China and Japan company participating to a still greater extent in the general prosperity and progress which was showing itself in that hitherto very conservative country.

Mr. T. Lloyd seconded the motion, which was adopted.

After the re-election of the retiring officers a vote of thanks was accorded to the Chairman.

INDO-EUROPEAN TELEGRAPH COMPANY, LIMITED.

The twenty-third ordinary general meeting of this Company was held on Monday at Winchester House, Old Broad-street, under the presidency of Mr. J. Herbert Tritton.

The **Chairman** stated that the result of the working for 1889 had been much the same as that for 1888. The receipts had been less by £2,038. The expenditure on commercial account had been practically the same. On maintenance account, however, the expenditure showed the large increase of £6,819, attributable entirely to improvements and additions to the line. In view of this outlay they carried over from last year £6,783. During the current year they would also have some extraordinary expenditure, but it was not likely to affect their dividend. They were still face to face with the fact of a decreased revenue from messages exchanged with India, to which he adverted at their last meeting, caused by the reduction of the tariff in 1886. Apparently decreased cost did not stimulate the demand in the case of long-distance telegrams. No doubt the systematised use of codes, and possibly that of registered addresses, had attained greater perfection. He feared they had not yet "touched bottom" in the matter of codes. It was one of the subjects which the International Telegraph Conference, which would shortly meet in Paris, would have before it, and with which, he imagined, they would endeavour to deal. Private messages, in plain language, hardly affected their business. It might scarcely be credited, but it was a fact, that in ordinary circumstances these messages did not amount to 1½ per cent. of the receipts on the Company's line. Their business was to cultivate trade messages. As he had said, the International Telegraph Conference was shortly to meet. The losses made yearly by low rates were now so large and the accumulated losses were so considerable that it was to be hoped taxpayers would not be further amerced to contribute still more towards the cost of international messages sent by merchants for purposes of profit, and by wealthy travellers and others for purposes of luxury and convenience. After warmly recognising the services of the staff, he concluded by proposing a resolution for the adoption of the report and the payment of a dividend for the half-year of 17s. 6d. a share, making, with the interim distribution, a dividend of 6 per cent. for the year, and a bonus of £1 a share, making the total return for the year 10 per cent.

Major-General G. B. Tremenheere seconded the motion.

In reply to Mr. Jackson, the **Chairman** stated that the Directors were in favour of strong reserves for all purposes, and for a great many reasons, only partly in connection with the termination of the concession. He would be very sorry to see any repayment of capital carried into effect at present. He thought that the risks of the future warranted their retaining the large amount they had in hand, and even increasing it.

The motion was carried unanimously, and subsequently the retiring Directors and Auditors were re-elected.

NEW COMPANIES REGISTERED.

Venezuela Telephone and Electrical Appliances Company, Limited.—Registered by Ashurst, Morris, Crisp, and Co., 6, Old Jewry, E.C., with a capital of £70,000 in £1 shares. Object: to act as contractors for the supply of electricity in lighting in Venezuela. The first subscribers are:

	Shares.
Sir D. Fox, Coombe Springs, Kingston-on-Thames ...	250
J. W. Phillips, M.P., 24, Queen Anne's-gate, S.W....	250
L. Franke, Winchester House, E.C.	2,000
W. P. Van Laar, 71, Rue de Petites Ecuries, Paris ...	250
D. Anthonesin, Amsterdam	500
J. Pimpson, Bushey View, Hampton Wick	100
H. P. Gilbert, 7, Poplar-grove, Shepherd's Bush-road	250

There shall not be less than three nor more than seven Directors. The first to be appointed by the subscribers to the memorandum of association. Qualification, £250. Remuneration, £500, divisible.

COMPANIES' REPORTS.

THE HOUSE-TO-HOUSE ELECTRIC LIGHT SUPPLY COMPANY, LIMITED.

Directors: Henry Ramié Beeton, Esq. (chairman), Charles T. D. Crews, Esq., Frederick James Burt, Esq., Robert Hammond, Esq. (managing director). Bankers: Messrs. Glyn, Mills, Currie, and Co., The Alliance Bank, Limited (Earl's Court branch). Solicitors: Messrs. Slaughter and May, 18, Austin-friars, E.C. Parliamentary agents: Messrs. Wyatt, Hoskins, Hooker, and Williams. Auditors: Messrs. Theobald Bros. and Miall. Secretary: H. St. John Winkworth, Esq. Offices: 117, Bishopsgate-street Within, London, E.C. Central Electric Lighting Station, Kensington, Richmond-road, London, S.W.

The following is the report of the Directors for presentation at the second ordinary general meeting, to be held at the Kensington station on the 5th May, 1890, at 4 p.m.:

In submitting to the shareholders the report of the operations of the Company to the 31st December, 1889, the Directors have pleasure in reporting the satisfactory progress of the business of the Company. The total number of shares issued is 8,322 ordinary shares of £5 each, and 100 founders' shares of £5, and in order to meet the further requirements of the Company, the Directors have issued £30,000 debentures, convertible into ordinary shares, which will provide plant at the Kensington station, capable of supplying houses wired for over 25,000 lamps, consuming 33 watts. Parliamentary powers, under the Electric Lighting Acts, 1882-8, giving the Company 42 years' tenure in a wealthy residential district at Kensington, have been granted to the Company. The district contains (north and south) a total of 12,854 private houses, 2,250 shops, 39 churches and chapels, 105 hotels and public-houses, 14 public buildings, including Board schools—£941,371 total rateable value. Since these powers have been granted and the supply mains laid, there has been a steady increase in the Company's business. The Company's mains now extend throughout seven miles of the principal streets of the area allotted to the Company by Parliament, reaching the extreme end of the eastern and southern boundaries at Sumner-place and the Fulham-road respectively. Since the 1st October, 1889 (the date the Company obtained power to lay supply mains in the public streets), orders for the supply of electricity have been received at the rate of about 400 lights per week, making at present a total of over 12,000 lights. The number of lights at present connected to the Company's mains is about 7,000, and the revenue from these lights already covers the whole of the working expenses, and the depreciation and establishment charges; so that a considerable profit will accrue when the extension of the lighting is brought up to the full power of the plant, as no further capital expenditure will be required, and the cost of producing the current will be relatively much reduced. The net revenue from the station (including the additional unit of plant for which capital has been provided) when in full work is calculated at £8,000 per annum, after allowing £7,000 per annum for working expenses, depreciation, &c. (A list is given of the present installations of the Company.) The central electric lighting station which has been erected by the Company at Kensington, is generally admitted to be the most perfectly equipped central electricity supply station that has yet been erected. The machinery is divided into three units of plant, each capable of producing electricity for 3,000 33-watt incandescent lamps burning at one time. The station is designed for 12 of such sets of plant, with a capacity for supplying about 100,000 lamps, installed in about 2,000 houses, and it is the Directors' intention to issue further capital from time to time to provide for laying down the additional unit, as the business of the Company extends. The excellence of the engineering work done by the Company in planning and laying down the Kensington station is so generally recognised, that the Directors are continually receiving enquiries from supply companies and local authorities throughout the United Kingdom, with a view to their contracting for laying down similar electric lighting stations elsewhere. The following is a list of the companies which have been registered by this Company, and of which this Company holds the whole of the founders' shares, entitled to half the profits after 7 per cent. has been paid on the respective capitals:

The Lancashire and Cheshire House-to-House Electricity Co., Ltd.
The Yorkshire ,, ,,
The Northern ,, ,,
The Liverpool ,, ,,
The Birmingham ,, ,,
The Manchester ,, ,,
The Midland ,, ,,
The Western ,, ,,
The South of England ,, ,,
The Scottish ,, ,,
The Irish ,, ,,

The Company holds a portion of the founders' shares in the following companies:

The Devon and Cornwall Electricity Supply Company, Limited.
The Portsmouth and South Hants Electricity Supply Co., Ltd.
The Sunderland and District Electricity Supply Company, Limited.

These companies are applying for provisional orders in their respective districts for the following towns:

Town.	Name of Company.
Aberdeen.....	Scottish House-to-House Electricity Co., Ltd.
Aberdare	Western ,, ,,
Barrow-in-Furness...	Lancashire and Cheshire ,,
Bedford	Midland ,, ,,
Birmingham	Birmingham ,, ,,
*b*Bolton..................	Lancashire and Cheshire ,,
*a*Bournemouth.........	South of England ,,

Bristol..................	Western House-to-House Electricity Co., Ltd.		
Bury	Lancashire and Cheshire		,,
Bootle	Lancashire and Cheshire		,,
Cardiff........	Western	,,	,,
*a*Coatbridge	Scottish	,,	,,
Cork	Irish	,,	,,
Croydon	South of England		,,
Coventry...............	Midland	,,	,,
Cheltenham	Midland	,,	,,
Darlington	Northern	,,	,,
Dundee	Scottish	,,	,,
Edinburgh & Leith	Scottish	,,	,,
Glasgow	Scottish	,,	,,
*b*Hawick	Scottish	,,	,,
Hanley	Birmingham	,,	,,
*b*Leeds	Yorkshire	,,	,,
*b*Liverpool	Liverpool	,,	,,
Leicester...............	Midland	,,	,,
Londonderry	Irish	,,	,,
Manchester & District *a*Moss Side .... *b*Stretford .... *b*Withington	Manchester	,,	,,
Malvern...............	Midland	,,	,,
Newport (Mon.) ...	Western	,,	,,
Newcastle	Northern	,,	,,
Nottingham	Midland	,,	,,
Oldham	Lancashire and Cheshire		,,
Oxford	Midland	,,	,,
*a*Plymouth	Devon and Cornwall Electricity Supply Co., Ld.		
*a*Prestor & Fulwood	Lancashire and Cheshire House-to-House Electricity Co., Ltd.		
Reading	South of England		,,
Rochdale	Lancashire and Cheshire		,,
Richmond	South of England		,,
Scarborough	Yorkshire		,,
Southampton...... ...	South of England		,,
*b*Sunderland............	Sunderland and District Electricity Supply Co., Ltd.		
Surbiton & Kingston	South of England House-to-House Electricity Co., Ltd.		
Tunbridge Wells ...	South of England		,,
Torquay	Devon & Cornwall Electricity Supply Co., Ld.		
Worcester	Midland House-to-House Electricity Co., Ltd.		
York	Yorkshire	,,	,,

a Formal sanction of the local authorities has been obtained.

b Negotiations are still pending with the local authorities for their consent.

The Company has given notice of intended application for pro visional orders in the following London parishes :

Name of Order.		District embraced.
North London Electric Lighting		*The parish of Islington and the district of the Hornsey Local Board.
North-West London	,,	†The parish of Hampstead and a portion of the district of the Willesden Local Board.
Fulham and Hammersmith	,,	†The parish of Fulham and the parish of Hammersmith.
Acton and Ealing	,,	The district of Acton Local Board and the district of Ealing Local Board.
Wandsworth District	,,	*The district of the Wandsworth District Board of Works.
Paddington	,,	†The parish of Paddington.
Lambeth	,,	*The parish of Lambeth.

* Formal sanction of the local authorities has been obtained.

† Negotiations are still pending with the local authorities for their consent.

As favourable business arises in connection with these provisional orders, further issues of capital will be made. The increasing favour with which householders are regarding the use of the electric light affords a field for the operations of the Company which is practically unlimited, and the moderate capital upon which the Company has to pay a dividend bears marked contrast to the capital of other companies seeking for similar business. Moreover, this Company has an immense advantage in being able to show a sample of its work in successful operation, and in having at its command the services of engineers who have been connected with house-to-house electric lighting from central stations from the beginning. The retiring Directors are Mr. Henry Ramié Beeton and Mr. Robert Hammond, who, being eligible, offer themselves for re-election. The auditors, Messrs. Theobald Bros. and Miall, also retire, and offer themselves for re-election.

BALANCE SHEET, 31ST DECEMBER, 1889.

Liabilities.

	£	s.	d.	£	s.	d.
Capital—						
8,322 fully-subscribed £5 shares......	41,610	0	0			
100 founders' shares	500	0	0			
				42,110	0	0
Six per cent. debenture issue—						
Fully subscribed				30,000	0	0
Creditors—						
On bills payable..............	304	7	9			
On open accounts	6,428	12	3			
				6,733	0	0
				£78,843	0	0

Assets.

	£	s.	d.	£	s.	d.
Kensington Central Station—						
Outlay in connection with erection of station, including a proportion of general and office expenses, labour and material on preparatory work of supply, buildings, plant, machinery, transformers, motors, electrical instruments, meters, mains, &c....................	31,661	7	2			
Deduct—Receipts for electricity supplied during construction and completion......................	168	19	10			
	31,492	7	4			
Provisional order, costs and expenses	1,537	7	7			
Lease account, law charges	56	10	6			
				33,086	5	5
Board of Trade—Deposit against Kensington provisional order........				1,000	0	0
Stock in stores	2,552	4	11			
Installations in progress	610	7	5			
				3,162	12	4
Calls on shares in arrears (since paid)				30	0	0
Debtors—For electricity	564	9	1			
For installation work, etc. ...	2,880	14	8			
				3,445	3	9
Construction Business Development Account—						
Fees for registration of the following sub-companies, in which the whole of the founders' shares are held by the House-to-House Electric Light Supply Company, Limited, viz.:						
South of England House-to-House Electricity Company, Limited ...	1,560	0	0			
Scottish ditto ditto ...						
Irish ditto ditto ...						
Lancashire and Cheshire ditto ...						
Yorkshire ditto ditto ...						
Midland ditto ditto ...						
Western ditto ditto ..						
Manchester ditto ditto ...						
Liverpool ditto ditto ...						
Birmingham ditto ditto ...						
Northern ditto ditto ...						
Devon and Cornwall Electricity Supply Company, Limited						
Legal charges and printing memoranda and articles of association in connection with the above-named companies	145	6	10			
Outlay on applications for provisional orders, parliamentary expenses, advertising, canvassing, and proportion of office and other expenses	7,042	14	4			
Deposits with the Board of Trade, returnable if orders not entertained	2,650	0	0			
				11,398	1	2
Goodwill account—Right of user of patents and covenant with managing director				7,500	0	0
City office furniture				177	12	10
Station building deposit account				235	2	8
Preliminary expenses account...........				3,431	14	4
Debenture issue expenses				89	10	0
Debenture issue account—						
Call due 18th January, 1890	4,040	0	0			
,, 18th March, 1890	5,310	0	0			
,, 18th June, 1890...............	5,310	0	0			
				14,660	0	0
Cash at bankers..	557	12	8			
Cash in offices, petty cash	45	15	7			
				603	8	3
Profit and loss account, balance.................				23	9	3
				£78,843	0	0

PROFIT AND LOSS ACCOUNT, KENSINGTON CENTRAL STATION.

DR.	£	s.	d.
Installation account—Materials and wages	5,231	4	8
Office expenses	280	14	10
Generating and distributing electricity—Working expenses, wages, coal, oil, etc., 1st October to 31st December, 1889.............	555	9	1
Ground rent, 1st October to 31st December, 1889	43	15	0
Rates ,, ,, ,, ...	29	3	4
	£6,140	6	11

CR.	£	s.	d.	£	s.	d.
Installations, wiring new premises......	4,832	7	7			
,, work in progress	610	7	5			
				5,442	15	0
Consumers' accounts for electricity, 1st October to 31st December, 1889......				480	14	0
Transfer fees				7	12	6
Discount and interest	326	16	5			
Less—Interest on debentures	141	0	3			
				185	16	2
Balance (loss) carried to balance sheet...				23	9	3
				£6,140	6	11

CITY NOTES.

Western Brazilian Telegraph Company.—The receipts for the week ended April 25, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Company, Limited, were £4,652.

Swan United Electric Light Company, Limited.—The Directors of this Company state that they have decided to pay an interim dividend at the rate of 6 per cent. per annum for the six months ending 31st March, 1890, to be distributed in accordance with the articles of association.

Consolidated Telephone Construction and Maintenance Company, Limited.—The Directors of this Company recommend dividends at the rate of 6 per cent. on the preference and 7 per cent. on the ordinary shares, less income tax, making with the interim dividends, 6 per cent. per annum on both descriptions of shares for the year ending March 31.

West India and Panama Telegraph Company, Limited.—The report for the half-year ended December 31 states that the revenue was £42,768, against £43,061, and the expenses £27,071, against £21,425, leaving £15,696, which, with the balance brought forward, makes a total of £17,305. The Directors propose a dividend on the first preference shares of 6s., and on the second preference, on account of arrears to December 31, 1889, 27s. 6d. per share, £516 being carried over.

Brazilian Submarine Telegraph Company, Limited.—This Company in their report for the half-year ended December 31 show a revenue of £121,119, and a working expenditure of £15,201. After providing for debenture interest and sinking funds and income tax, there remains a balance, which, added to £2,609 brought forward, makes a total of £93,975. First and second interim dividends amounting to £39,000 have been paid, and £45,000 transferred to the reserve fund, leaving £9,975 to be carried forward. The receipts of the Company for the week ended April 25 amounted to £4,709.

Submarine Cables Trust.—This trust, in the report for the financial year to April 15, states that the revenue, including £165 brought forward, amounted to £23,259. The coupon due on October 15, 1888, was paid in two instalments—viz., £2. 12s. 6d. on April 15, 1889, and the balance of 7s. 6d. on May 15 last. The first payment of £2. 12s. 6d. was included in the previous year's accounts, but the balance of 7s. 6d. was a charge against the revenue for the past year. The expenses of the trust amounted to £1,274, and the payments on account of the coupons to £21,553, leaving £431 to be carried forward. In addition to paying the 7s. 6d. outstanding on the October, 1888, coupons, the coupons due on April 15 and October 15, 1889, have been met in full out of the revenue for the past year. The certificate holders have thus received interest at the rate of 6⅜ per cent. in the past year, as against 5⅝ in the previous year. The coupons due on April 15, 1890, are in arrear, and will be paid as soon as the trustees have sufficient money in hand for the purpose.

PROVISIONAL PATENTS, 1890.

APRIL 21.

5996. **Improvements in electric incandescent lamps.** William Brooks Sayers, 71, Norroy-road, Putney.

6000. **A new and improved method of making house or other connections with or without fuses to underground electric mains.** William Harding Scott and Laurence, Paris, and Scott, Limited, Gothic Works, King-street, Norwich.

6005. **Electric lamp adjuster.** George Henry Sayer, 88, Queen Victoria-street, London.

6032. **Improvements in electric heating apparatus.** Mark Wesley Dewey, 45, Southampton-buildings, London. (Complete specification.)

6037. **Improvements in and relating to electric railway vehicles.** Mark Wesley Dewey, 45, Southampton-buildings, London. (Complete specification.)

APRIL 22.

6041. **Improvements relating to the transformation and utilization of electrical energy.** Mark Wesley Dewey, 45, Southampton-buildings, London. (Complete specification.)

6082. **Improvements in the means of and apparatus for distributing and collecting electricity for the propulsion of vehicles.** John Edward Waller and Edward Manville, 1, Queen Victoria-street, London.

6083. **Improvements in effecting the electric propulsion of tramcars and apparatus therefor.** John Gordon, 191, Fleet-street, London.

6100. **Improvements in electric machines for covering wire.** John Scott and Frank Elmer Davis, 76, Chancery-lane, London. (Complete specification.)

6120. **Improvements in and relating to systems of electrical distribution.** Charles Jacob Kintner, 45, Southampton buildings, London. (Complete specification.)

6121. **Improvements in apparatus for the receipt of coin and for permitting the use of telephonic apparatus in exchange therefor.** Henry Harris Lake, 45, Southampton-buildings, Middlesex. (William Gray and Charles Soby, United States.) (Complete specification.)

6124. **Improvements in man holes for underground electric conduits.** James Ferguson Munsie, 45, Southampton-buildings, Middlesex. (Complete specification.)

6125. **Improvements in and relating to underground main and branch conduits for electrical conductors and to feeding devices therefor.** James Ferguson Munsie, 45, Southampton-buildings, Middlesex. (Complete specification.)

6126. **Improvements in electrical signalling apparatus for police service and the like.** Robert Dunbar Radcliffe, 45, Southampton-buildings, London. (Complete specification.)

6138. **Improvements in screens or shades for lamps and gas or electric lights.** Samuel Clarke, 24, Southampton-buildings, London.

APRIL 23.

6156. **An improved electrical switch for the better and more safe means of breaking the continuity of an electrical circuit of high voltage, and again establishing the same.** George Schultz, 33, Delafield-road, Old Charlton, London.

6177. **Improvement in secondary batteries.** George Barker, 77, Colmore-row, Birmingham. (Henry Woodward, Canada.)

6223. **Improvements in galvanic batteries.** Manuel Anci[illegible]ar, 53, Chancery-lane, London. (Rafaél Zerda Bayon, South America.)

APRIL 24.

6236. **An improved storage or tertiary electric battery.** Alfred James Jarman, 4, Moorfields, Fore-street, London. (Complete specification.)

6266. **Improvements in means for use in electrolysis.** Julius Marx, 47, Lincoln's-inn-fields, London.

6267. **Improvements in means for connecting electrical conductors, applicable more especially for connecting conducting wires or strips to electrodes used in electrolysis, and as a safety device for electrical purposes.** Julius Marx, 47, Lincoln's-inn-fields, London.

APRIL 25.

6326. **Improvements in electricity meters.** Emile Batault, 78, Fleet-street, London. (Date applied for under Patents Act, 1883, Section 103, 28th September, 1889, being date of application in Switzerland.)

APRIL 26.

6359. **Improvements in the sections and forms of iron rails, in the method of laying them, and placing within them an electric conductor; and in the manner of applying the electric brush of an electric motor to the aforesaid electric conductor for use on electric tramways and railways.** Henry James Peddie, Tynecastle Iron Works, Gorgie-road, Edinburgh.

6389. **An electric motor.** André Blattner, 29, Stephen-street, Tottenham Court-road, London.

6392. **Improvements in safety-fuses for electric currents.** Otto Titus Bláthy, 28, Southampton-buildings, London.

SPECIFICATIONS PUBLISHED

1881.

783. **Electrical conductors.** Perry and Ayrton. 11d. (Third edition.)

1888.

742. **Tanning hides by electricity.** Groth. 8d. (Second edition.)

9171. **Electric lighting of railway trains.** Langdon. 11d. (Reprints, with alterations.)

1889.

3988.** **Electric lighting, &c.** Anglo-American Brush Electric Light Corporation, Limited. 6d. (Third edition.)

6410. **Galvanic cells.** Burnell (Wilms). 8d.

7796. **Electric conductors.** Benson. 6d.

8030. **Charging electric accumulators, &c.** Unger. 6d.

9119. **Electric bells, &c.** Fiford. 6d.

9133. **Electric lamps.** Lake (Lacombe and Co.). 6d.

9162. **Dynamo machines.** Brown. 8d.

9304. **Electrical switches.** Barnicoat. 6d.

1890.

1878. **Electric insulating compounds.** Williams. 6d.

2986. **Electric lamp sockets, &c.** Wollen and Werline. 8d.

3008. **Storage batteries.** Hollingshead and Carney. 6d.

3013. **Storage batteries.** Hartmann. 8d.

3484. **Electric secondary clockwork.** Schweizer. 6d.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Anglo-American Brush	—	2½
— Pref.	—	1⅞
India Rubber, Gutta Percha & Telegraph Co.	10	18
House-to-House	4½	5
Metropolitan Electric Supply	—	5¾
London Electric Supply	5	2⅞
Swan United	3½	5
Crompton & Co., Pref.	—	5½
National Telephone	5	5¼

NOTES.

Franklin.—Thursday, April 17th, was the centennial anniversary of the death of Benjamin Franklin.

Paris Conference. — The International Telegraph Conference in Paris opens on the 15th of the current month.

Electric Lighting Acts.—The Electric Lighting (Scotland) Bill has been read a first time in the House of Commons.

Electric Sugar.—The tools of the electric sugar swindlers have been released from custody, after having been detained for 16 months.

Paris.—It is announced that the firm of Mildé et Cie. have received the concession of the section of Paris extending from the Boulevard Malesherbes to the fortifications and the Seine.

Electrolin.—Mr. Kapp, according to the *Elektrotechnische Zeitschrift*, recently paid a visit to the carriage lamp works of Wensky and Steinbrink to investigate the properties of the wonderful liquid electrolin.

Chicago Telegraphs.—The Chicago Board threatens that if the Western Union Telegraph Company does not return to its 25 per cent. rate they will build a commercial telegraph line between New York and Chicago.

Society of Arts.—Dr. J. A. Fleming will no doubt have a large audience at the Society of Arts on Wednesday next, when he is to give a paper on "Prof. Elihu Thomson's Electro-Magnetic Induction Experiments."

Journal.—The *Journal* of the Institution has been received containing the discussion on Mr. Swinburne and Mr. Esson's papers and the paper and discussion on "Alternating *v.* Continuous Currents in Relation to the Human Body."

Alternate Currents.—M. Borgman has been pursuing researches into the mechanical effects of alternate currents after those of Prof. Elihu Thomson, and has embodied his experiments in a paper before the Académie des Sciences.

Submarine Cable Manufacture.—In Calais a large manufactory of submarine cables is to be established. This is the first attempt of the sort made abroad, English manufacturers having practically had the monopoly of the industry.

A Long Private Line.—The longest private telephone line in the world is owned by Mr. De Bardeleben, of Bessemer, Alabama. It is 30 miles long, cost over £1,000, and runs from that gentleman's iron works to his offices and branches in seven adjacent towns, and is also joined to a local exchange.

Steam Fittings.—All the steam traps working in the Edinburgh Electrical Exhibition are the "Lancaster" patent high-pressure steam traps, and all the pedestals carrying the line shafting are the "Lancaster" patent adjustable pedestals, both of which are manufactured by Messrs. Lancaster and Tonge, Pendleton, Manchester.

Switches.—One of the leading London companies has this week handed to Messrs. Dorman and Smith, of Manchester and London, an order for delivery in one consignment for shipping abroad electric light accessories, including 5,000 combined porcelain switches and fuses of various sizes, together capable of controlling over 50,000 lights.

Variable Electro-plating.—In view of the fact that electro-plated articles after a certain amount of use are found to have the silver worn off in certain parts, Oetzmann, by a patent process of manufacture, electro-plates spoons, forks, etc., on the parts most subject to wear and friction with about three times the usual quantity of silver.

Electro-Harmonic Society.—We have received the report and balance-sheet of the Electro-Harmonic Society, and are most pleased to see it in such a flourishing condition. The surplus assets are over £95. The society, which commenced with 115 members, numbered at the end of the first season 155; of the second, 216; of the third, 253; and now, at the close of the fourth season, consists of 278 members.

The Weems Electric Express.—Mr. David Weems is pushing forward with his five miles a minute electric railway. He has recently taken out patents for special rails to run his trains upon, these rails comprising, besides the usual rounded surface, a lateral projection under which a frame from the car axle can be so adjusted that the car cannot jump the rails.

Weber's Electrodynamic Law.—According to a note to the Académie des Sciences, M. H. Poincaré has pointed out certain errors in Maxwell's study of Weber's electrodynamic law, showing that the result true for closed currents is not so for open currents, and touches on an error in the equation which serves a point of departure in Maxwell's analysis leading to the errors mentioned.

Caoutchouc.—The axiom that supply attends demand proves often true in an unexpected way. We are lately threatened with the diminution of the rubber trade from South Africa, when simultaneously we learn on the one hand of a new product which promises to provide gutta-percha artificially, and on the other Mr. Stanley opens to our view millions of trees in Central Africa with a plentiful supply of caoutchouc.

Rating of Machinery.—A conference of members interested in the Rating of Machinery Bill has been held under the presidency of Sir Henry James. An attempt was made to define "fixed machinery," but, after a prolonged discussion, the effort proved futile. Sir Henry James has advised that the Bill shall be recast, declaring that machinery shall be rated, whilst adding a schedule setting forth exceptions.

Electric Omnibuses.—The Ward Electric Car Company, Limited, has removed its offices to 38, Gracechurch-street, E C., and premises have also been taken at Dacre-street, Westminster, where the experimental omnibus can be seen by appointment. The company have contracted with the Electric Construction Corporation, Limited, for their first line of electrical omnibuses to run between King's Cross and Charing Cross.

Institute of Medical Electricity.—Viscount Templetown has accepted the chairmanship of this institute in the place of Mr. Wm. Lant Carpenter, who, owing to ill-health, has resigned his office to the great regret of all concerned. Lord Templetown is a well-known electrician, and has taken strong interest in the Institute of Medical Electricity since its inception. There is no doubt that under his rule the scientific thoroughness of the institute will be maintained and its usefulness further developed.

An Electric Railway Joke.—The proceedings of the committee on the Central London Railway Bill were enlivened the other day by an unlooked-for comicality from Sir Benjamin Baker. "Now, Sir Benjamin," said an opposer of the Bill, "what about the conductors for your currents; are we to presume that they will both be covered ?" To this the hero of the Forth Bridge, with a tinge of sorrow for such simplicity in matters electrical in his voice, replied, "My dear sir, did you *ever* see two naked conductors running alongside a tramcar ?"

French Accumulators.—It is stated that the Société Française d'Accumulateurs Electriques intend to seize the Laurent Cely accumulators, manufactured by the Société pour la Travail Electriques des Metaux. This latter company were intending to supply the Continental Edison Company with 100 tons of accumulators at a price slightly less than 2f. per kilogramme (10d. per lb.); they would have guaranteed, besides, the maintenance for an annual charge of 10 per cent. on the cost price. M. Popp also was on the point of giving an important order for accumulators to the same company.

Supplementary Storage Cars.—The president of one of the street railway companies in a city near Chicago says that they find that there is little traffic on the lines after 10 p.m., but the cars are obliged to run until 1.30 a.m. To run the steam plant during that time is quite expensive, and, after careful investigation, they have concluded to place several storage battery cars in use from 10 p.m. to 2 a.m., thus giving the machinery a good rest. The batteries can be charged during the day, while the plant is in operation, and one charging will be ample for the trips required in three night runs.

Cardiff Station to be Closed.—Several users of the electric light at Cardiff have received a circular from the Brush Electrical Engineering Company, intimating that, in consequence of the rules of the Board of Trade in regard to overhead wires, and the decision of the Corporation of Cardiff not to consent to the application of the company at present for a provisional order enabling them to place their wires underground, the company have no alternative but to close their station. They state that next year they will renew their application for an order, and hope then to obtain the consent of the Corporation, when they will be prepared to carry out the electric lighting of Cardiff by means of underground mains.

Wrexham.—The Wrexham Town Council are exercised over the time to be allowed in the provisional order for compulsory purchase. Twenty-one years was first suggested, and this was extended as a compromise to 30 years. Alderman R. Jones said the matter was one for the younger members, as he did not expect to live to the end of the period. The clerk remarked that before the promoters can obtain their order they must have the consent of the Town Council, unless the Board of Trade dispense with that consent. In order to avoid going to London, Alderman J. Jones suggested that they should submit the difference to some disinterested man. He afterwards changed the suggestion to conference with three of the promoters, and this was carried.

Folkestone.—An adjourned meeting of the Corporation was held last week to receive a report from the Electric Lighting Committee. This recommended that Messrs. Crompton's request for an extension of time for completing the electric light should be granted on condition that the work should not be commenced before October 1st and should be completed by December 31st, and that the present agreement and the original contract be at once executed under deed. Mr. Thompson moved and Mr. Pursey seconded that the report be received and adopted. Some discussion arose as to whether shareholders in the gas company were allowed to vote, and the town clerk, upheld by the opinion of a judge of the Supreme Court, and of their own recorder, decided they could not, Alderman Banks strongly protesting. The resolution was carried.

Single-Circuit Watchman's Signal.—An ingenious electric signal indicator for a watchman's round in a factory or other establishment, worked on a single circuit, is described by the inventor, M. Reverchon, in *Cosmos* for May 3, and is illustrated by diagrams of the working parts. In principle the arrangement consists of a single wire, with its return going in series to each post or watchman's position, and open at the further ends. Each post has a commutator, the movement of which by the man on his rounds throws in a fine wire resistance. At the office is a dial face, revolved by clockwork, on which an ink-needle attached to a galvanometer or ampere-meter traces a mark. As each successive resistance is thrown in circuit, the deflection varies and leaves a trace of the time of the watchman's signal. The system is worked out on principles differing from those at present in use, and should be simple and efficient in action.

A Motor Without Fields.—Mr. J. C. Henry, whose name is known among early workers on the other side of the Atlantic, has introduced a form of motor decidedly novel certainly, but the efficiency is not stated. This is a motor absolutely without field-magnets. There are three armatures revolving in their own induced fields, centred at the three angles of an equilateral triangle, with the smallest clearance space between each, all geared to the same driving wheel, and so arranged as to keep up a steady torque, depending upon the dimension of the armature and the strength of current. As plenty of ventilation will be secured, a very large current density can be used. The motor has been constructed and run in an experimental form. The practical utility of this truly extraordinary motor remains to be proved, but its consideration is recommended to those who are disposed to overlook the magnetic effect of the armature in ordinary dynamos and motors.

Chatham.—At a meeting on Friday of the Chatham Board of Health, the clerk said he had received a communication from the Chatham Electric Lighting Company, which stated that they had received a telegram from their parliamentary agents with reference to the provisional order for the electric lighting of the district. The consent of the local authorities was required by Saturday, if the order was to be saved, and they asked the Local Board to consider the matter at their meeting. The resolution was moved that no limitation be placed upon the proposed order as to the number of years over which the company should extend operations according to the Act, this being 42 years. The clerk having stated that the Corporation of Rochester had imposed no limitation in this respect, the resolution was carried. Several alterations in the order, so as to prevent one local authority being bound down by the action of another, were suggested by the clerk, and agreed to.

Alternate Motor Tramcars.—Considerable interest is excited in electrical circles, says the *Electrical World*, in the street railway system that will soon be vigorously pushed by the Westinghouse Company. It is understood that the alternate-current motor is to be used, and this alone is enough of a novelty to force the system into public notice. Just how well the alternating-current motor will perform under the very severe conditions of street car service it is difficult to say, but it is certain that the subject has been carefully considered, and it is understood that the preliminary trials have been encouraging. The real merits of an electric railway system can, however, only be determined after exhaustive trial in real service, and the performance of the first alternating motor road installed will be watched with the greatest interest. The new company, it is added, starts with a powerful backing, and a determination to push, so that we may soon expect to see its system in actual operation.

Board of Trade Clauses.—In the House of Commons on May 1st, Mr. Kimber asked the President of the Board of Trade whether, as the Board had struck out at the instance of local authorities Clause 6 of the Board's model order prohibiting a supply of electricity beyond the area of supply, he was prepared to make a similar concession to electric lighting companies, and whether he would grant to companies the same concession, namely, an appeal to the Board of Trade in the matter of compulsory works, which the Board made to local authorities at their recent interview with the officials of the Board of Trade on the 24th of April last. Sir M. Hicks-Beach said his answer to the first enquiry must be in the negative—seeing that the position of a company limited to an area, and possibly with other companies in adjoining areas, was distinct from that of a local authority having jurisdiction over their own local district, even though this should be larger than their area of supply. As regarded the second enquiry he was prepared to treat companies and local authorities alike.

Electrical Execution.—The attempt to push execution by electricity to the bitter end has had a sudden and unexpected result. The New York Legislature passed a short Act abolishing capital punishment altogether. This is currently believed to be due to the influence of the Westinghouse Company. We hear, further, according to a Dalziel telegram from New York, that the Edison Electric Company has been served with the papers in a suit brought against it by the Ganz Electric Company, of Buda-Pesth, damages being laid at half a million of dollars. The Ganz Company owns the patent of the alternate electric system, and it maintains that Mr. Edison, president of the Edison Electric Company, used influence with the Legislature of New York State, and induced them to adopt the alternate electric system for the execution of criminals, thereby prejudicing the public against the Ganz electric system. It was necessarily demonstrated that the Ganz system was sufficiently powerful to kill instantly, and ordinary consumers of electric light have in consequence become alarmed and prejudiced against it.

Overhead Wires.—Mr. C. Harrison, chairman of the Parliamentary Committee of the London County Council, reported that in conference with the chairman of the committee, and the agents and Mr. Wolfe Barry, the Subways and Overhead Wires Bill had been revised so as to limit its operation to overhead wires without excepting any area, and they had authorised the solicitor to instruct the agents to prepare, in accordance with standing orders, a filled up Bill containing the revisions for the committee of the House of Commons. The agents were in communication also with the Telephone Company to endeavour to settle clauses. Mr. Fardell moved that the Council disagree with the report. Mr. Cohen seconded, and said he did not believe that the Council wanted to come into conflict with the City, and if the City was not excluded, the Corporation would assuredly oppose the Bill. Sir John Lubbock appealed to the committee to reconsider the matter, and said the City would certainly oppose it. The chairman joined in the appeal. Mr. Hopkins moved the adjournment of the subject, which was agreed to.

Bridging the Thames.—The latest American enterprise is, to say the least, startling. There has just arrived in London, according to the *Pall Mall Gazette*, with plans of gigantic proportions, an engineer of the name of Tetley, whose object is nothing less than the bridging over of the Thames, from London Bridge to Putney. His idea is that by means of a series of steel tubes thrown across the river from bank to bank, on a level with the present bridges, he may form a magnificent avenue throughout the above-mentioned distance. His plans contain designs for bazaars, houses of entertainment and amusement, broad pavements, or sidewalks, as he prefers to call them, a double avenue of trees, and two lines of electric tramway running along the middle of the road from end to end. He proposes to light the tunnel beneath throughout with electric lights, and to have openings at intervals for the convenience of the freight-carrying barges and vessels which will continue to ply on the river. The design is Utopian in its gigantic grotesqueness; but who knows? we may yet ride to Putney on an electric tram, and visit a café chantant overhanging mid-stream, while we sip our black coffee and smoke our mild Havanna.

South London Mains.—The Paving and General Purposes Committee of the St. Saviour's District Board reported that the clerk had received a notice from the London Electric Supply Corporation, Limited, that, in exercise of the powers conferred by their provisional order of 1889, they intended, at the expiration of one month, to commence the laying of electric mains across Borough High-street and through Southwark-street and Stamford-street. The committee ordered that a letter should be written to the London County Council expressing the opinion that the company should be required to lay their mains in the subway in Southwark-street, to the full extent thereof, in lieu of breaking up the roads in that portion of the route. The committee also ordered that notice should be given to the company that the Board would require the reinstatement of all roads and pavements disturbed or interfered with at the expense of the company. Mr. Hale moved the adoption of the report, and in answer to a question by Mr. Meikle said the County Council had the power to compel the company to lay their mains in the subway. The surveyor (Mr. Norrish) said he was told by the engineer to the company that the Council would probably not allow them to lay their mains in the subway. The report was adopted.

Concentric Wiring.—Mr. J. D. F. Andrews, who has lately made London his headquarters, has taken Mr. H. H. Gray, civil engineer, into partnership, and has removed his office to 41 and 42, Parliament-street, Westminster, where his business of electrical engineer will be continued under the well-known name of J. D. F. Andrews and Co. The firm intend applying their energies especially in the direction of the equipment of electricity supply stations, in which direction Mr. Andrews has had long experience, in conjunction with his late partner, in Glasgow. The other specialities of the firm relate particularly to Mr. Andrews's concentric wiring for electric lighting in buildings and ships, which he introduced into several installations on land, and upwards of 100 on steamers, which appear, from the testimonials received by his firm, to have given satisfaction. Mr. Andrews was the first to apply this mode of wiring for interior lighting, and has taken out several patents for recent improvement especially in the joints and switches. We have received a circular setting forth the advantages of the system, and we may probably describe the details at an early date. We understand Messrs. Andrews and Co. have made special preparations for supplying the trade with their various specialities, and are about to issue their trade catalogue and price list.

Artificial Guttapercha.—With reference to the artificial guttapercha we mentioned last week details of the composition and manipulation are not yet forthcoming, but the inventor forwards us the following further particulars: Five kinds have been made. Three are soft and elastic, like cured rubber; two other kinds are hard and elastic, resembling hard wood or bone, except in elasticity. A sixth is nearly finished. It is lighter than water, but is not intended for electrical purposes. The specific gravity is from 1·5 to 2·75; the specific inductive capacity averages 2. The insulation resistance is given as higher than guttapercha—about equal to glass. As to cost, by purchasing the raw materials by the ounce and working them up in the laboratory, the cost has been from five farthings to twopence per pound. Therefore, on the large scale it should be easily made for a penny a pound. The colours hitherto made are black, dark blue, and three shades of brown. We are informed that Mr. Latimer Clark, F.R.S., has examined the specimens, and has expressed his approval of their general qualities, being entirely distinct from those of the "rubber substitutes" he has had hitherto brought to his notice; but he has not yet tested them electrically. Full tests are promised as soon as possible by those in whom the public can have confidence. A great many requests for samples have been received, which it has been impossible at present to supply, and orders have also been received. The stuff burns only with great difficulty, which is an advantage over most insulators.

Dynamos for Telegraphing.—The dynamo plant of the Western Union Company at Albany, N.Y., which has been in operation since July, 1889, displacing 7,000 cells of Calland battery, says the *Electrical World*, has greatly improved the service. The arrangement is somewhat different from that in New York, Pittsburg, and Chicago. The plant, which is located in the Edison light station, two blocks distant from the telegraph office, consists of nine Edison dynamos—three of each polarity for regular service, and three spares arranged to supply either polarity, driven by a 7½ h.p. electric motor. Each potential is furnished by an independent machine, the first of 90 volts, the second 150 volts, the third 250 volts. All the dynamos are wound to generate currents of higher potential, and are driven at a slow speed as a matter of economy. Three potentials are found to be sufficient for all the main battery service. Artificial resistance is added to the city wires and loops and other short wires, so that the 90-volt current can be used with perfect success. Duplicates of every part of the plant, both electric and steam, are so arranged that instantaneous changes can be made without interrupting the service. The currents are carried to the telegraph office in an aerial cable. There is also a spare cable between the station and the office on an entirely different route. An independent plant has been installed at an intermediate point on the route of the spare cable for use in case of serious accident or interruption at the regular station. The spare cable connects the telegraph office with both stations. The independent plant consists of two dynamos generating one current of each polarity at a potential of 250 volts. This is used to replace the highest potential sent out from the regular station, and supplies the quadruplexes. By means of rheostats this current is cut down to meet the requirements of the other circuits. In no branch of the service has the improvement caused by the adoption of the dynamo current been more marked than in the Gold and Stock Ticker system. The dynamo current is also used to run a Sprague motor in the office, operating the pneumatic tube and the copying press. The plant was designed and installed by Mr. Alonzo Beatty, of New York. Negotiations are pending for the addition of machines to supply local circuits.

City Lighting.—At the last meeting of the Commissioners of Sewers the form drawn up for presentation to the Board of Trade consenting to the applications of the Brush Company and the Laing, Wharton, Down Syndicate was agreed to. Mr. Pannell moved that the Commission refuse to consent to the application of the London Electric Supply Corporation and the Metropolitan Electric Supply Corporation respectively. He said that another opportunity would be given to these two companies to make terms with the Commission. There was yet a third district of the City which had not been allocated, but these two companies having failed to come to terms they had no alternative but to oppose their applications. This, it was stated, was done not in opposition, but to give the companies another chance. A letter was read from the London Electric Corporation, complaining that the Commissioners had agreed to material modifications on the original stipulations in favour of the Brush Corporation, and the Laing, Wharton, and Down Syndicate, who are, therefore, now to be allowed to contract on terms which have never been offered to the London Corporation, and which they had no opportunity of considering. Under these circumstances they beg to protest against any such contract being concluded with the two companies in question to the exclusion of this corporation. The report of the Streets Committee, stating that they did not see any necessity for departing from the previous conclusions relative to the letter of the London Electric Supply Corporation, was, however, agreed to. Referring to the deputation of the same committee to Taunton, a report from Mr. Preece was read and circulated, stating that the price for the public lamps in Taunton was £22. 10s. each per annum for eight hours' lighting per day. This, if reduced to the kind of lamp proposed to be used in the City of London, and to the number of hours of lighting that were essential there, meant that the charge was equivalent to £45. 6s. 6d. per lamp per annum, which showed that the price the Commissioners of Sewers had agreed to pay the Brush and Thomson-Houston Companies was a very fair and moderate one. There was a certain prejudice against underground wires, but in a long discussion with Mr. Massingham at Taunton Mr. Preece said he was able to show him that ultimately it was really cheaper to place wires underground than to erect them overground. The visit to Taunton was considered very satisfactory.

Central London Railway Bill.—The committee on this Bill met for the ninth time on Thursday, May 1. Sir John Fowler was further examined as to estimates, and said, that having regard to the fact that iron would be largely used, and knowing how much iron fluctuated in value, it was exceptionally necessary to have an ample estimate. Mr. Alfred Lyttelton addressed the committee on behalf of the Duke of Westminster in opposition to the Bill. On Friday, Mr. Pope, Q.C., on behalf of the London, Chatham, and Dover Company, said that the whole thing was an experiment, and experiments should not be made on streets like Holborn and Oxford-street. On Monday, Mr. Littler, Q.C., spoke on behalf of the Corporation of the City of London, who were doubtful as to the practicability of the proposed scheme, though they were always ready to support any well-considered plan of locomotion for the metropolis. Mr. Bell, the general manager of the Metropolitan Railway, who was examined in support of the opposition, said the traffic on the underground had diminished greatly on account of the omnibus competition. He did not think they would carry 28,000,000 passengers as was estimated. If any further development of underground traffic were called for within the metropolis his company ought to have the first chance. He admitted that the proposed route contained the plum of the traffic, and that the Metropolitan would be very glad to lay down a line along it if there were the least likelihood of obtaining the consent of the frontagers. To alter the Metropolitan Railway so as to introduce electricity would cost about a quarter of a million. The company opposed the scheme because it would abstract traffic from their system. Mr. Seaton, the engineer, and Mr. J. Wolfe Barry, engineer of the Tower Bridge and consulting engineer to several railway companies, also gave evidence adverse to the proposed line. On Tuesday Mr. Pember, Q.C., replied on behalf of the promoters, and dealt with the points raised. As regards the damage to the subsoil, he would be willing to have a clause inserted in the Bill providing that the owners of any subsoil should be compensated under the 68th section of the Lands Clauses Consolidation Act, and as regards the other points, judged by the ordinary standard of parliamentary proof, the evidence in favour of the scheme and the probabilities of its ultimate success were unusually high. The opposition to the scheme was intended to bring about the utter waste of all the time, money, and energy which had been expended upon its promotion, to say nothing of the disappointment and mortification to the promoters, or the discouragement which, by such action as rejecting the Bill, Parliament would throw upon legitimate enterprise directed to satisfy great public needs. The committee, after having deliberated in private for about half an hour, found that the preamble had been proved, on the understanding that (1) a compensation clause should be inserted in the Bill similar to the one in the Midland Railway (Additional Powers) Bill, 1881; (2) that stringent clauses should be inserted affording every opportunity to the engineers of the Corporation of London and of the County Council to inspect the works during their progress, lest any possible damage should be done to the sewers; (3) that the estimated capital of the company should be somewhat reduced; and (4) that until the City and Southwark Subway had been opened and used by the travelling public for a certain time no prospectus should be issued or capital raised by the Central London Company. The committee then adjourned until Tuesday, the 13th inst., for the discussion of clauses.

Bromley.—As briefly alluded to last week, a meeting was held on April 24th at Bromley, Kent, to consider the question of a central installation of electric light. At this meeting Mr. John Wright, A.M.I.E.E., representative of Messrs. Laing, Wharton, and Down, gave some particulars and figures. He first dwelt fully on the advantages of the pure electric light over gas, and described the arc and incandescent systems. He advised the inhabitants of Bromley to follow in the steps of Taunton, where from a small beginning they had just declared a dividend of 6 per cent. on £20,000, and expected next year to be able to declare 12 per cent. as actual profit. An ordinary gas jet consuming four cubic feet of gas per hour would give about 12 candles. This at 3s. per 1,000ft. would work out at ·566 of a farthing per jet per hour. An incandescent lamp registering on the photometer 26 candles took 50 watts, which at the rate of 6d. per unit, was 1·2 farthing per lamp per hour. They would see from that, that from the incandescent lamp they got a light equal to 2·16 gas jets, so that multiplying ·566 by 2·16 they got 1·22256 of a farthing per lamp per hour as opposed to 1·2, the charge for electric light. It might be said that the gas company could afford to supply the gas at even less than 3s. per 1,000. His answer was simple—that the electrical authority could also afford to supply the current at much less than 6d. and then have a handsome profit for division amongst the shareholders. Dealing with the initial cost, an installation of 150 incandescent lamps and 10 arcs of 1,200 c.p. each—with a gas engine and two dynamos, one for the incandescents and one for the arcs—would cost about £1,390. If they had only one machine, not more than £1,250. The maintenance would be 400,000 cubic feet of gas for the gas engine £55, with removals £22. 10s.; carbons and oil, waste, stores, etc., £19. 6s.; attendance £80; total, £176. 16s. The earnings of the incandescents would be 9,000 units at 6d., £225; 10 arcs at £16 each, £160; total, £385. This would leave a balance of £208. 4s., or after deducting 5 per cent., a nett balance of £145. 14s. If a small vertical engine and boiler were used the cost of the plant would be reduced to say £1,120, and the maintenance to £156, leaving a nett available balance, after allowing 5 per cent., to £173. An installation of 500 incandescent lamps and 50 arcs would cost complete about £4,500; and for maintenance with engine and boiler and two dynamos: Coal, say 70 tons at 17s., £59. 10s.; renewals (340) at 3s. 9d., £63. 15s.; carbons, £120; attendance, £150; oil, waste, stores, etc., £50; total, £443. 5s. The earnings would be 500 incandescents, 25,000 units at 6d., £625; 50 arcs at £16, £800; total, £1,425. This would leave a balance of £981. 15s., or after allowing 5 per cent. off there would be a nett profit of £756. 15s. So that it would be seen as they increased the size of the plant the initial cost and maintenance became proportionately less and the profit proportionately greater; the interest on the first plant amounting to a little under 11 per cent., but in the case of the latter to a little over 16 per cent. They would observe that he had not allowed for rent of premises in those figures as he was unacquainted with that item in their district, but he should imagine that an allowance of £40 a year on the latter and £15 on the former would be amply sufficient. In conclusion, he asked them to combine together for the formation of a syndicate so as to enable them to possess themselves of the advantages above enumerated. It only wanted some 20 or 30 gentlemen in the first instance to step forward and promote a company which must have a very successful career, as there was a large field open to them, not only in Bromley, but in Bickley, Chislehurst, and the other districts to which there would be no difficulty whatever in extending their cables. A further meeting took place on Wednesday for the purpose of forming a syndicate, and a provisional committee was formed. Mr. Wright and Mr. Schiassi were unanimously appointed to give an estimate as to cost of a plant of 300 lamps and 40 arcs, and report to committee. Mr. Podger presided.

ELECTRIC TRACTION DATA.*

BY A. RECKENZAUN.

Of the various questions connected with electric traction, the branch to which I have the honour of calling your attention to-night appears to me fundamental to a complete knowledge of the subject. It relates mainly to tractive force and mechanical resistances on tramways. It is a subject which is not as fully appreciated by electrical engineers as it should be, although it forms the very basis of street locomotion, and I venture to say that future improvements in the economy of electric traction will in a large measure depend upon minute attention to details relating to this branch of the science. The very existence of tramways as substitutes for the common road is concentrated in one point—viz., the reduction of tractive resistance to a minimum.

It is a well-known fact that the traction expenses on horse tramways constitute about two-thirds of the entire working expenses, and it has long been the aim of engineers to find an economical mechanical substitute for animal power. Electricity has found great favour with tramway men in the United States, and there is every probability of similar developments in Europe at a not distant date. Improvements can only be brought about by experience, and experience must be gained in actual practice and by careful observation. These, again, can be supplemented by data obtained from those who preceded us, and it is my intention to bring in a condensed form such data from which you will be able to draw your own conclusions, and which will guide you in future and progressive efforts.

In order to provide facility for traction, we must have a solid permanent way, and excellent rolling surfaces. The practical value of a good rolling surface can scarcely be over-estimated. The rails must be rigid, parallel, and fixed to solid foundations. In America, flat step rails without grooves are used; these offer less resistance to traction than grooved rails, but as a rule they are not so solidly laid as English rails. According to Mr. D. K. Clark, the resistance to traction on an ordinary railway may be as low as 6lb. per ton; but so low a resistance cannot be obtained with grooved rails which are exposed to the incidents of mud, grit, stones, and dirt, and which, moreover, have frequent and sharp curves.

Mr. Henry Hughes deduced from experiments on tramways a tractive resistance of about 26lb. per ton; often more, occasionally less. Such high resistances as these are readily accounted for, when it is considered that the flanges of the wheels frequently take a bearing on the bottom of the grooves, or on the dirt embedded therein, at the same time that the wheels roll on the surface of the rail; for thus the wheel rolls on two different radii simultaneously, and grinding of surfaces in contact must result. It may also occur that one wheel is running on its proper bearing surface, whilst the other, belonging to the same axle, has its flange touching the bottom of the groove, when, by virtue of different circumferential velocities, additional friction is introduced. Sometimes the rails are a little out of gauge. All these circumstances augment the tractive force requisite with grooved rails. The horse, if it could speak, would be a good witness, but failing his verbal evidence the dynamometer has been consulted. Better than the mechanical dynamometer, however, is the ammeter. A dead-beat ammeter indicates instantly the slightest variations of tractive resistances, and I venture to say that it will be through the judicious and more frequent applications of this instrument that material improvements both in the permanent way and in the rolling stock of electric tramways will be effected.

Probably the most interesting and complete tests with horse cars were those made by M. Tresca. He proved, experimentally, that the groove in the rail was the direct cause of a large portion of the resistance to traction. An ordinary car with its four flanged wheels was propelled over the tracks of the Paris-Versailles tramway, and it was found that the average tractional resistance amounted to $\frac{1}{100}$th of the gross weight, or 22·4lb. per ton. Subsequently two of the flanged wheels, both on one side of the car, were removed and replaced by flangeless wheels, when the resistance, all other things remaining the same, amounted to only $\frac{1}{147}$th of the weight, or 15$\frac{1}{4}$lb. per ton. The gross weight of car and passengers was 5·67 tons. These experiments show conclusively that at least half the power is wasted in friction between the sides of the groove and the wheel flanges.

The force required to start a tramcar and to get up speed is necessarily greater than the force required to maintain a given speed uniformly. It was found that the starting force is from four to five times that necessary for running on the level road. Curves also increase the resistance very much. In dry weather, on curves of 50ft. radius, the resistance to traction is doubled, and on those of 35ft. radius trebled; but when the rails are wet this resistance, due to curvature, is considerably reduced. Water, plenty of water, on the rails acts as an efficient lubricant, and you will see by statements later on the general effect of wet rails. Short wheel bases, bogies, or radiating axles, render motion on curved rails easier, and flexible axle-boxes are now greatly favoured, especially in the United States for the same reason.

The effect of gradients is a matter of simple calculation. It is the maximum gradient on a given line which determines the size and power of the electric motor. Allowing 22·4lb. tractive force per ton, we should have to exert a pull of 134·4lb. with a six-ton car on a level road. This, at the rate of seven miles an hour, or 616ft. per minute, would give us 2·5 h.p. effective on the axles. If we have to overcome a gradient of 1 per cent., or 1ft. in 100, the resistance due to gravity will also be 22·4lb. per ton, therefore we shall require about 5 h.p. to pull this car up a gradient of 1 in 100. With a 2 per cent. rise the power will be three times as great as on the level, and, roughly speaking, each per cent. of grade demands as much energy as the propulsion of a given weight on a horizontal road if the speed is to be constant. On steep gradients, however, it is customary to run slower, whereby some of the energy is saved at the expense of time.

The time at our disposal will not permit of descriptions of particular systems of electric traction, nor of the relative merits of each, and we shall confine ourselves entirely to statistics on tractive force, no matter how this force is transmitted; and we shall merely consider the question of moving a given load on a given track by means of the electric current. In order to ascertain the amount of energy used on electric cars I have made, in conjunction with the Electric Car Company of America, a long series of systematic tests both on an experimental track built for this purpose, as also on the public roads under all sorts of conditions of traffic. Whilst on the experimental track we could run at any speed we liked, and without stoppages; on the public streets we were confined to the speed of horse cars in front and behind us, besides taking up and putting down passengers and regulating our vehicle to the general traffic of some of the busiest streets of Philadelphia.

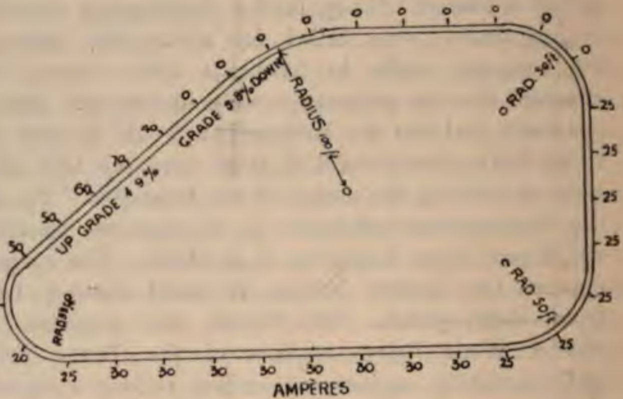

FIG. 1.

This experimental track was laid in an irregularly shaped yard as shown on the diagram No. 1, and it was intended to represent as difficult a line as is likely to occur in actual practice. Its entire length was 1,005ft., the ends being so joined that the cars could circulate continually. Five and a quarter journeys round this track represented a mile run. There were four curves—two of 50ft. radius, one of 33ft., and one of 100ft. Tangent with the 33ft. curve was a gradient of 4·98 per cent. rise, which descended on the other side at the rate of 5·8 per cent., and joined the curve with a radius of 100ft. On this track we carried out tests and recorded observations which may be counted by the hundred thousand. The following figures relate to experiments made with a car in the autumn and winter of 1887-88. The vehicle was an ordinary 16ft. two-horse car, with two axles, one motor, and a set of storage batteries. It weighed, with several men on board, 5·3 tons; its wheel base was 6ft., and one axle only was driven by an electric motor with intermediate spur gearing.

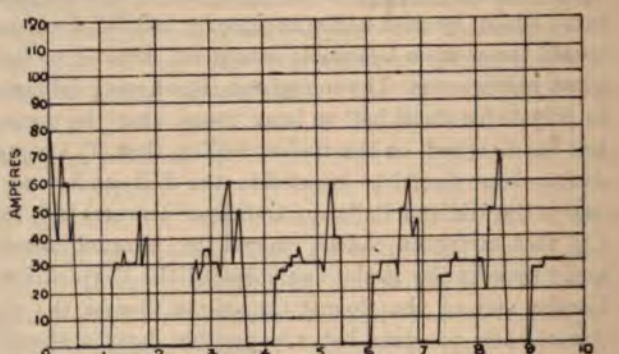

FIG. 2.

The rails were the ordinary American flat rails, grooved only at and near the curves, which represented a large percentage of the entire track. With a set of 84 cells of a nominal capacity of 150 ampere-hours, this car made 230 trips round this track, representing an aggregate of 43·8 miles with one charge of batteries. The car was only stopped and started 14 times. The actual running time was 6$\frac{1}{4}$ hours, giving an average speed of seven miles an hour. At the commencement the E.M.F. of the cells on closed circuit was 160 volts, and at the end 145·2 volts, the average from actual measurements was 157 volts. The maximum current used on the steepest grade was 70 amperes; at starting, on the curve or grade, it rose to as much as 120 amperes. The average current consumed was 22·6 amperes, which corresponds to 141 ampere-hours taken out of the battery. The current on the level road fluctuated between 18 and 25 amperes. The diagram (No. 1) representing this track has marked upon it the current rates used at the various points of the journey. It will be observed that the car ran by momentum during a considerable portion of the journey, this momentum being acquired during its downward movement upon the 5·8 per cent. gradient, the brake being only slightly applied, and the stoppages during this experiment, as I have said, were few.

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* Paper read on Wednesday, April 30, before the Old Students' Association of the City and Guilds of London Institute.

A mean ot 4·75 e.h.p. was thus expended, giving a consumption of 29·69 h.p. hours supplied by the battery; and the maximum energy given off at any moment was 10,500 watts, or 14 e.h.p. Allowing an average efficiency of 75 per cent. in the motor, and 85 per cent. in the gearing, we obtain a total efficiency of nearly 64 per cent. between the motor terminals and the axle, or about 3 h.p. available for traction. Thus, the mean tractive force throughout the 43·8 miles run was 160lb., or about 30lb. per ton. This is very low, considering that out of the entire distance we had only 21 miles of tolerably level track, the rest being made up of 3·4 miles of 33ft. curves, 7·07 miles of 50ft. curves, 3·64 miles of 100ft. curves, and 4·05 miles of ascending grades of 4·98 per cent. On the other hand, there were 3·8 miles of descending grades of 5·8 per cent., which furnished momentum right along the 100ft. curve until the car passed completely into the upper 50ft. curve on the right-hand side of the diagram. Converting the work into ton-miles, which is probably the most rational way of comparing figures, we get 5·3 × 43·8 = 232·14 ton-miles at an expenditure of 29·69 b.p. hours, and this gives nearly 7·78 ton-miles per h.p. hour. We have obtained much better results than this with a subsequent car containing various improvements, and, on one occasion, this larger car made 63 miles on the experimental track, each h.p. hour producing 10·9 ton-miles, but these are exceptional feats, and our present object is to consider practical results corresponding with everyday work—industrial results, in fact.

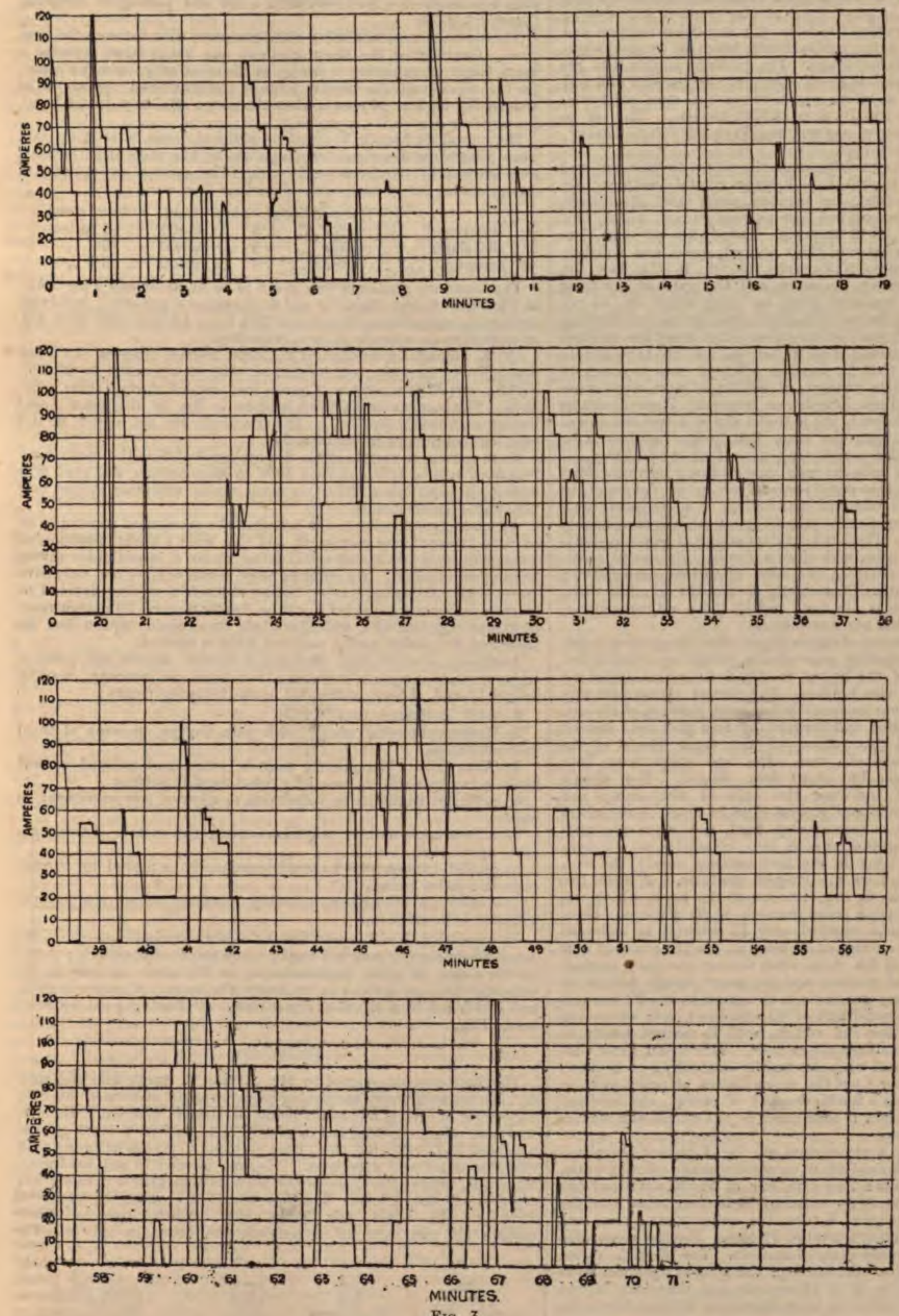


Fig. 3.

Three men, each well trained for his work, were necessary for these tests, and their respective duties were as follows: One man took charge of the switch in front of the car and the hand-brake; in fact, he performed the ordinary function of a driver, taking care that the car moved at regulation speed on the level, that it did not "race" down grades, nor go too slowly up the inclines, and that it took the curves with safety. The second man, with a timepiece in his hand counted the number of round trips and recorded the same; he also took voltmeter readings at equal intervals. The third attendant had the more difficult task of reading the deflections on the ammeter and write down the values. In order to ensure uniformity in the time between each reading, and also take as many readings as possible, one has to learn to write down a certain number of figures in a given time, putting down cyphers, to fill up time when the ammeter needle is at zero. The number of observations written down during the 43-mile test were close upon 7,500, or one reading every three seconds. Considering the rapid variations in the current on uneven tracks, it is very important that readings are recorded at the shortest possible intervals in order to arrive at a correct average. The specific gravity of the cells was tested before starting, when they were fully charged, and it averaged 1,186 deg. At the end of 6¼ hours, when the cells were practically discharged, the density fell to about 1,126 deg. The accumulators were then recharged for six hours at the rate of 30 amperes, when the electrolyte assumed its original specific gravity. It is impossible to keep the acid in every cell at the same density; there are always slight differences, and we had to take the mean of the entire number of cells to ensure accuracy. Diagram No. 2 represents the currents used during six journeys round the experimental track, and this was virtually repeated throughout the tests, except when stopping and starting. Now compare this with diagram No. 3, showing the current variations out in the crowded streets. You will observe a number of tall narrow peaks running down to the zero line at frequent intervals. During these intervals the car was either stopping or running by momentum. The vertical lines in this diagram represent minutes and seconds, and the horizontal lines amperes measured on the car during the entire journey from Twenty-third-street to the Exchange in Philadelphia and back to the Graysferry depot, and from thence again to its starting point, a distance of about seven miles. Every corner on this diagram represents a movement of the switch by the driver.

The switch was constructed to throw the various distinct coils on the field-magnets of the motor into parallel or in series, or into several intermediate steps and these steps can be readily detected on the sharply defined junctions of the lines showing amperes. The average current consumed throughout this round trip, down town and back to the depot, amounted to 31 amperes. The weather was dry, windy, and the road very dusty. Allowing for this, as well as the frequent stoppages and slowing down in order to keep pace with the horse cars on the same line, it appeared that there must have been some waste of energy. The diagram shows that there was a continuous effort of getting up great speed at one moment and slowing down the next. It shows that the driver was somewhat nervous and inexperienced to driving in the public streets, hence the frequent alternate use of high currents and brake. The gradients on this road are not very severe, the heaviest is about 4 per cent., and several of 2 and 3 per cent. Calculating as before, and allowing the same efficiency, we should get an average tractive force of 39lb. per ton. The car in this case carried 23 passengers one way and 30 on the return journey, giving a mean load of seven tons.

Numerous journeys were made through the city with this car, and some days after the above event I took again careful readings; the driver was more experienced, less nervous, never used the utmost electrical power at his disposal, and the average current during two round trips came to only 23·11 amperes. Twenty-five per cent. less than formerly, under similar conditions of load, speed, and weather. Although the average height of the peaks was less in this case, the number of them was nearly the same, and the gaps representing periods when no current was used gave, on being added up, 45 per cent. of the total. Thus, for nearly half the time the car was running by momentum alone. It must be remembered that every few hundred yards there is a street crossing those we ran on, and all these streets have their tramways, so that for common safety it was necessary to slacken down at each square or block of buildings, even when other traffic and passengers did not impede our progress. These diagrams teach us two important lessons, one is that a skilful driver can economise energy to a large extent, the other that proper appliances for regulating the power within a wide range are a distinct advantage.

After a good shower of rain the tram rails assume a tolerably clean appearance. The mud is then easily squeezed out by the flanges of the car wheels. Thus I have observed that during, or immediately after a rainfall, the energy necessary for propelling a vehicle is considerably less than in dry weather. There is a positive saving of power amounting to from 15 to 50 per cent. with clean wet rails. By careful observations we were enabled to record the effect of various comparatively small obstacles on the rails. The ammeter showed the minutest variations in tractive force: it is far more reliable than a dynamometer, since it had neither friction nor momentum.

Snow is the greatest enemy of tramways, it offers the greatest resistance to traction. Anticipating snow storms, which occur rather frequently in some parts of the States, we fitted the experimental car with a snow plough and wire brushes. The plough shears were supported by a balanced frame underneath the front platform of the car. These shears could be raised and lowered by foot pressure. Behind the plough shears and just ahead of the front wheels of the car were brushes made of steel wire, and these were kept scraping over the rails by their own weight. The plough served the purpose of removing the bulk of the snow, and the brushes swept the rails and grooves clean in front of the wheel flanges. One day when it snowed very hard, and when the rails were covered about a quarter of an inch deep, we ran the car out upon the experimental track, using in the first instance merely the wire brushes and a little sand on the steepest gradient. It took two minutes and eight seconds to run once round the track, which was soon cleared of snow, taking a mean current of 50 amperes. Snow fell hard all the time, yet it required only 35 minutes to make 20 successive trips, with an average of 30 amperes. In the course of four hours the snow was nearly 2in. deep, when the car was again started. The brushes alone were of no avail, and the snow plough had to be applied. The first journey was made in two minutes and 20 seconds, but with the enormous expenditure of 80 amperes; each succeeding trip, however, took less time and energy, until it reached nearly to its normal value corresponding to clean rails. This would show that with proper appliances, and with cars rapidly succeeding each other, the track can be kept clear; but the accumulation of much snow in the first instance occasions a fearful demand of energy, and without plough and brushes the snow is compressed by the wheels and renders progress almost impossible.

Recent tests made by a commission on the Frankfort-Offenbach Electric Tramway, which has been in constant operation for six years, gave the following results: Two cars, one of which contained the motor, the other an ordinary car attached to it, were taken over the line. The motor car weighed 4 tons, the ordinary car 2 tons, and 20 passengers 1½ tons, giving a total of 7½ tons. Measurements with an ampere-meter were made every 5 seconds. The E.M.F. varied between 240 and 300 volts. At starting, the current used was 80 to 100 amperes, which fell to 40 in 10 seconds, and the mean current on the level road at 8 miles an hour fluctuated between 15 and 25 amperes. On a gradient of 2·85 per cent. 55 to 60 amperes were recorded, and the mean current over a distance of 1 mile, occupying 7 minutes, was found to be 21·48 amperes, and this included four stoppages. The highest amount of energy recorded at any moment, when starting, was 21,700 watts.

Miles per hour.	Volts.	Amperes.	Electrical h.p.
7·5	404	9·5	5·15
9·3	416	10·4	5·79
9·1	393	10·7	5·40
10·9	434	16·1	9·35
12·4	433	15·4	8·93

Another test on a gradient of 6·58 per cent. rise one-tenth of a mile *in length* gave the following results:

Miles per hour.	Volts.	Amperes.	Electrical h.p.
2·73	347	27·2	12·65
4·20	403	27·4	13·47
9·30	409	31·3	17·14
6·20	365	32·4	15·85

Dr. Louis Bell, in an interesting paper published a few months ago, gave the results of his experiments on the La Fayette road (Ind.), from which I take the foregoing instructive figures. Experimental runs were made on a level road with a car and passengers weighing together 8,200lb.

These results are remarkable when compared with those on the level road. Considering the steep gradient, one would have expected a much larger consumption of energy at the necessarily low motor speed. On the other hand, the tractive force on the level road appears to be abnormally high at all speeds when the motor efficiency should be at its very best.

More recently Mr. O. T. Crosby published some interesting data concerning three American tramways which, like those of La Fayette, were worked by overhead conductors. The average expenditure of energy on one car on each of the following lines was:

	Watts.	Electrical h.p.	Load.	Aver. speed.
Richmond	4,883	6·5	8,500	6 miles.
Cleveland	4,986	6·6	9,500	9 ,,
Scranton	5,587	7·4	9,500	5·7 ,,

The maximum gradients were given to be at Richmond 9 per cent.; at Cleveland "very slight"; and at Scranton 7 per cent., involving maximum expenditures of power of 25·6 h.p., 15 h.p. and 19·2 h.p. (electrical measurements on cars) respectively.

Dr. E. Hopkinson ascertained the mean tractive force on the Bessbrook-Newry tramway, and he showed that it amounted to 28·9lb., 27·4lb., and 37·1lb. per ton of gross load hauled during three journeys. The increase in the third journey is due to the mean speed having been nearly doubled. The gradients are not severe in this case, but continuous in one direction.

From numerous sources at our disposal we find that the mean tractive force may be anything from 30lb. to 50lb. per ton, and that it is seldom, if ever, below 20lb. on level roads, excepting under very favourable circumstances.

All these figures point to the fact that the mechanical resistances on existing tramways are very great, and that even a slight reduction at a comparatively small cost would bring about a considerable saving in traction expenses. By reducing these resistances we not only save power with existing appliances, but by virtue of a smaller demand of tractive force we are enabled to utilise lighter motors, lighter gearing, lighter storage batteries, which, in their turn, again require less for their own propulsion until a practical limit is reached.

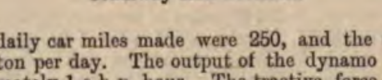
Assuming, *a priori*, high efficiency in electric motors and gearing, improvements as regards mechanical resistance on tramways may be looked for and, I hope, attempted in the following points:

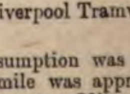
1. Solid, well-fixed, parallel rails.
2. Perfect cylindrical wheels, with thin flanges, or some of them without flanges.
3. Clean rails. The grooves may be swept and watered several times a day by a vehicle especially fitted for this purpose.
4. Sufficient flexibility in axle-boxes to allow of free movement in curves.
5. A reasonable number of graduations in the motive power regulated by a switch.
6. Skilful driving, which should occasionally be proved by careful tests and power curves.
7. Automatic sand-boxes on steep gradients where the natural adhesion is insufficient.

In conclusion, I will repeat that a frequent and judicious use of the ammeter on electric cars will amply repay you for the trouble; it will be the means of great improvements, in the same manner as the indicator diagram enabled us to study the nature of steam-engines, and which has been the most direct means of effecting great economy in working.

Discussion.

The discussion was opened by **Mr. Albion T. Snell**, who said that Mr. Reckenzaun's very interesting paper strongly confirmed his own experience in several important points of electric traction. He had, however, rather expected the subject to be treated in a more general way, and had, with that view, been prepared to give some figures with reference to his own experience. He was pleased to see his friend, Mr. Thos. Frazer, there, and would leave him to give a detailed description of the Electric Traction Company's tramway plant at Barking. He would only make the following general statements: The cars were six in number, one being in reserve. The daily car miles made were 250, and the coal consumption was one ton per day. The output of the dynamo per car mile was approximately 1 e.h.p. hour. The tractive force varied between 20lb. and 30lb. per ton. He had a large experience of electric haulage in collieries and mines, both with endless rope, the main and tail, and the single rope systems, and also with electric locomotives. The conditions obtaining in mines were very different from above ground. There were three types of rails in general use, known as the bridge rail, the T rail, and the vignole rail. The roads were usually badly laid, and the tops, originally rounded, soon wore flat owing to the


Tramway Rail Sections.


Liverpool Tramway.

tubs often running with spragged wheels on the steep inclines. The latter was the better class of rail; but the sharp-topped T rail was often found. Owing to dirt, the friction of the tub axles, and the bad ballasting of the road, the resistance to motion averaged 70lb. per ton. He had found it of great importance to ascertain by experiment the actual tractive force required. The horse-power could be easily found by the formula—

$$\text{H.P.} = \frac{\text{W K } n}{33{,}000} \pm \frac{\text{W } 2{,}240 n}{33{,}000} \sin \theta,$$

where W = total load in tons;
K = resistance to motion, including friction of axles, in pounds per ton;
n = speed in feet per minute.

Even with the best laid colliery roads it was not safe to take K at a lower value than 70, and on bad roads it sometimes rose to 100lb. or 120lb. On these very bad roads it might happen that even on a down grade of 1 in 12 the friction would be sufficiently great to prevent the load from running by gravity, and the second term of the right side of the equation would be small compared with the first. At Liverpool the tramway companies used the centre flange wheels and sunk rails, but he was not aware of the friction value. It would probably be greater than with the inside flange and ordinary sunk rail. He would congratulate the Old Students' Association on the paper laid before it. He was particularly struck by the very interesting curves so carefully prepared by Mr. Reckenzaun. They were most valuable.

Mr. Thomas Frazer, engineer to the Electric Traction Company, said he had come more to hear what others had done than to speak of his own work. With reference to the friction stated as 8 to 12 per 1,000, this differs very much according to state of the track. In most instances the track was not kept clean and the friction, owing to the company's fault, was far higher than it should be. The track should be scooped, cleaned, and watered. The only company he knew where this was properly done, and the track kept thoroughly watered, was at Liverpool. It was very necessary to pay great attention to this point, and to know exactly what the friction amounted to. In many cases it would amount to 25lb. to 35lb. per ton. There is, of course, a difference in principle between the calculation for a self-contained car and a locomotive with one or two cars, for in the latter case the friction of the locomotive itself would not be counted in the traction, whereas, with self-contained cars, the weight of the driving apparatus is added. He reckoned 1 per cent. for an ordinary car; with self-contained cars it would be much larger. The formula given by Mr. Snell might be written more simply k W D for the tractive force on the level, k being the friction constant, or including the tractive force on the rise $(k+\theta)$ W D, θ being the sine of the angle of gradient. If the tractive force required is 1 per cent., and the rise 6 per cent., this would, of course, make the calculation ·01 + ·06 W D. He preferred, however, to write the formulæ $f p d$ and $(f+x) p d$, and this form was the form he had always used. The ammeter, however, was the best and true guide to the tractive force required. He wished to mention the immense opposition he had found from what he might call "horsey" people, and wherever electrical engineers go they will have to count upon this opposition.

Mr. W. B. Esson, after acknowledging the indebtedness of the association to Mr. Reckenzaun for his paper, gave the working expenses of the different metropolitan tramway companies per car mile run, and mentioned that out of seven companies only three had paid dividends worth mentioning. It so happened that these three were the very companies whose expenses per car mile were highest. The mean appears to be somewhere between 8d. and 10d. per car mile, while on the Continent the cost of running is somewhat lower, and varies from about 5d. to 7d. Looking at a company like the North Metropolitan, with over £1,000,000 of capital and 40 miles of rails, having a total annual expenditure of nearly a quarter of a million, a saving of 1d. per car mile means a net gain of £25,000 per annum, while on a tramway not paying a dividend, a reduction of the expenses by 1d. per car mile would mean the beginning of a very respectable return to the shareholders. The North Metropolitan costs about 9½d. per car mile, inclusive, but of this a large amount is, of course, fixed charges, which would not be altered by introducing electrical instead of horse traction.

Let us see roughly to what extent the cost per car mile would be influenced by substituting electricity for horses. For each car are required nine horses—eight working horses and one spare. Each horse, with harness, will cost about £50. For the nine horses this means £450 in all, and, as the average working life of a tram horse is three years, this means £150 per annum, or, say, in round figures £3 per week. Taking the keep of a horse at 15s. per week, this amounts to £6. 15s. for keep of nine horses, or, with the original cost of £3 per week added, £9. 15s.—say, with attendance and so on, 35s. per day per car. If we take 80 miles per day, which is probably a fair average for a car, this works out at something like 5d. per car mile. This agrees very closely with Mr. Reckenzaun's statement that the cost of traction is about two-thirds the total cost of working the line.

What electrical engineers have to compete with is this 5d. As regards steam tramways, it may be said that they have not satisfactorily solved the problem. There is considerable difficulty in getting at the working expenses of these, as, generally speaking, where steam tramcars are run, horse cars are running at the same time, but, as far as the accounts can be analysed, the saving does not appear to be very great. The steam tramway having the least expenses per car mile is that of the North Staffordshire Company, where they run at 8·71d.

The conditions upon which the tram companies will allow electrical engineers to carry out their experiments may be somewhat onerous, but are at the same time quite justifiable from their point of view. They have their rolling stock, they have their lines already laid, and the conditions upon which a company will allow electrical cars to run are that neither the rolling stock nor the line be interfered with. They will allow electrical engineers to take their cars and pull them electrically, but they will not permit them to be altered so as to make them electrically self-contained until the success of the system is placed by preliminary experiments beyond a doubt. London tramcars cost something like £170, and the electric traction company which elects to work a section of the line has either to provide electric engines to haul the existing cars, or to provide new cars properly adapted to carry accumulators. In running a section of the North Metropolitan line at Stratford some years ago Mr. Elieson had this problem to face, and had constructed several electrical locomotives which took the place of horses. These locomotives weighed, with their cars fully loaded, about 11 tons, the motor working them requiring about 6 e.h.p. on the level to attain a speed of eight miles an hour. The locomotives were in this instance unnecessarily heavy, and it may be reckoned that 10 tons would fully cover the weight of an engine with its accumulators and motor with loaded car behind it, the electrical horse-power required on the level being about five. Such an engine with motor gearing and a double set of accumulators will cost about £620, of which £300 will be for the accumulators. The cost of the charging station, of engines, boilers, dynamos, and fittings for a plant of 50 cars will come to about £150 per car, so that the original cost of the plant will be £770 per car. An average of 10 i.h.p. per car will be required at the charging station, this giving, for 16 hours a a day, 160 h.p. hours. The coal consumed ought not to exceed 4cwt., but we may be liberal and allow 5s. per day per car for coal, oil, waste, etc. Then taking 10 per cent. as repairs, depreciation, and renewals on £470 (the share of cost of engine and dynamos, and cost of motors, gear, etc., per car), and 25 per cent. on £300, the cost of accumulators, the depreciation and renewals amount to £47 + £75 = £122 per annum, or, say, in round numbers, 7s. per day. Added to the coal, etc., this makes the total cost per car per day 12s., or just about one-third of what it now costs with horse traction. This is, of course, a rough estimate, and heavy gradients and sharp curves may increase considerably the full consumption. But when all allowances are made for such contingencies, it is clear that the cost for electric traction must be less than for horse traction, and that the profits on the running will enable a higher dividend to be paid, though the capital is considerably increased.

There is no doubt that electric railways in America have very great advantages over tracks laid in the streets in Great Britain. Mr. Reckenzaun has told us how very important it is to keep the track clear of dirt and grit, and on overhead lines it is obvious that these conditions can be fulfilled far better than on street lines. Out of all the railways in America in 1887 only two were worked on the conduit system, all the others having overhead conductors. The former method of working seems quite unsuitable for crowded streets, such as we have in the metropolis and in other large towns, and since the overhead system is inadmissible, we must, therefore, look to accumulator traction for the solution of the problem.

Dr. Silvanus Thompson, after congratulating Mr. Reckenzaun on the great interest of his paper, referred to what might be considered the lack of proper engineering skill as opposed to electrical knowledge in the early stages. Mr. Elieson's cars were made over to a firm whose knowledge of engineering was supposed to be such that it would bring the scheme to fruition. Yet the fact was that the cars had been spoilt for want of sufficient engineering knowledge. Mr. Elieson had carefully arranged a second switch to turn on a small current to start the cars. The first thing done when the cars were taken over was to do away with switch as unnecessary. The consequence was that the whole current went through the motor, the wheels were split, and the teeth of the gearing were torn out. This was a purely mechanical breakdown. Referring to the extremely interesting and useful curves Mr. Reckenzaun had drawn up and plotted with so much care, it seemed to show the necessity for some kind of registering ammeter.

Dr. Sumpner said he had been surprised to find in recently published data of the working of the Sprague roads what a relatively small amount was the actual cost of traction. The proportions for one road were as follows:

	Conductors.	Line.	Power.
On a 6 per cent. rise	71·5	1·8	26·7
On the level	67	18	15
Another road gave			
On the level	66·3	12·7	21
And the average was	69·5	11·5	19

From which it is seen that by far the largest expense is that for the wages of conductors, the cost of power being quite subsidiary. Analysing the actual cost of power at the station, the same thing appeared. Of the 19 per cent. the proportions were: Labour, 11; fuel, 6·3; oil and waste, 1·7.

Mr. Reckenzaun briefly replied. The high cost of labour in America was, of course, the cause of the large proportion for conductor charges, the men sometimes receiving 3dols. or 4dols. (12s. to 16s.) a day. One of the greatest drawbacks in England to the extension of electric traction was the officialism of the authorities. In America there was usually no one to consult. If a company wished to put up a line they just put it up, and asked no one's permission, and no one interfered. There was nothing to prevent a person running a tram line wherever they wished, and as a matter of fact, one company need not consult another, but were perfectly at liberty in some cases to run their own cars amongst those of another so long as they did not interfere or kill anybody. In England there was just the opposite extreme. There was the Board of Trade to consult; Major-General Hutchinson had to report; in one case he had had to do with there were two vestries each trying to find every possible objection. Finally, there would be an Act of Parliament to be obtained, costing some £1,000 or £2,000, and probably taking in all two years before the electric trams could run.

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IMPORTANT NOTICE.

We may occasionally follow the lead of our American Contemporaries, especially when they point out a serviceable way. They are not backward in asking their friends to do all they can for the welfare of the paper. We ask our friends to remember us. No paper that we know ever refuses Subscribers or Advertisers. Nor do we; in fact, we invite them, believing that they will get full value for their money.

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THE LANE FOX PATENTS.

A small company or syndicate has been formed to exploit these patents, which are amongst the oldest in the new departure of electric lighting. The patents were, we believe, for a long time under the control of the Anglo-American Brush Corporation, and it would be interesting to outsiders, and especially to those who may be asked to contribute money, to know why if these patents are thought and ruled by eminent men to be so valuable, the Brush Company did not retain them at all hazards. We have watched the fluctuations of this company with great care, and have found that usually the administration savoured of a keen knowledge of business, and very unlikely to misunderstand or to neglect what might perchance contain the germ of a huge monopoly. Certainly, then, very full information must be given to intending investors to explain why these patents have passed out of the hands of business men, into the hands of a new syndicate at this late or tolerably late portion of their life. We may explain at this point that the peculiar conditions of the Lane Fox patents have ever been a source of considerable surprise to us, and we cannot help feeling that there must exist some grave doubts as to the contention in regard to the validity of the patents held by so many eminent men.

Patent law is understandable only to the initiated, but its greatest simplicity seems to consist in the property than anyone can patent anything, good, bad, or indifferent; and that the patent holds good till it is challenged by other interested parties in the law courts, when probably the longest purse carries the day. The most important point for difference of opinions in Lane Fox's patent concerns the "earth return." The galaxy of talent speaking in favour of the validity of this claim is so great that it becomes almost suicidal to differ with it; yet we are bound to say, whether the claim is held to be valid or no, we have always looked upon it as a monstrous claim—utterly devoid of originality or of new combination, as common property, well known and well understood in every application of electricity by every schoolboy. When experience was less than it is now, patent agents would usually demur to the attempt to patent anything which would naturally occur to everybody required to carry out certain work. There are only two ways of getting a return—everybody knew them in 1878 just as well as they know them now; and if it was valid to patent an earth return it was valid to patent a metallic return—that is, to patent the only two ways in which a return could be had. Mr. Lane Fox did not discover an earth return; he used it in no new sense. He taught us nothing new of the "conductive" or of the "inductive circuit." Whatever may be the value of the other claims of Lane Fox is a question we do not care to discuss.

They may warrant the formation of a syndicate or of a company, but it must be remembered that a patent taken out in 1878 has but a short time to live. By the time a company is floated and organised the end will be nearer still, and as within two years the amount of business to be done would be comparatively little, even if no one thinks it worth while to contest the validity of the patents. It would not pay anyone at this late stage of patent life to trouble about validity. Whether he believed the patent to be good or bad, it would be cheaper to pay a royalty than to spend money in law.

What we have said as regards time applies with tenfold force to the question of lamp patents. We take it that everybody concerned is heartily sick of litigation, and that the Swan Company has a practical monopoly till its patents run out. What can be done with Lane Fox's patents of 1878-1880? even if valid and uncontested. The former would be out of date before a factory would be in good working order, and when can investors hope to get back their investments from the other and later patent? What headway would a business make in two or four years handicapped, as it would be, by the necessity to fight against strong competitors in the field. Before the end of the longer period, too, competition would have increased a hundredfold.

It may be well to briefly recapitulate our objections to the formation of a company to work these patents. In the first place, the patents are so nearly run out that there is no time left to make a business. In the second place, some, at any rate, of the claims are of doubtful validity and may be contested, and, lastly, the history of the patents requires elucidation.

In fairness to those who hold the patents we ought to give credit to the opinions held on the subject. Thus, Sir W. Thomson testifies that Lane Fox's system of distribution of incandescent lamps was "a novel and important suggestion," and that the patentee was "justified in considering that he had made an important discovery," that "it was novel at the date of his patent," and "is a useful and largely used invention at the present day." Prof. Perry says: "I consider that Lane Fox's specification of 1878 is one of the most wonderful for originality in scientific accuracy." Mr. W. H. Preece says that to the best of his belief "the combination claimed was new at the date thereof." Mr. Latimer Clark is also favourable; while Prof. S. Thompson says "the system of distribution by means of a set of mains and branches to lamps arranged in parallel and with secondary batteries as regulators, was new, useful, and sufficiently described." These are, as we have said, weighty opinions. Almost all agree, also, that earth return includes not only the return ordinarily known as earth, but metallic return also. As we contend any claim of this character in any electric circuit is not patentable, it matters not whether we agree in the contention that "earth return" includes "metallic return," though, again, with the utmost diffidence we beg leave to differ from the doctors and express an opinion contrary to theirs. True, terminals of instruments are often marked "earth" "line," but there always has been a tendency in practice to definitely state whether the return was "earth" or "metal." What of the controversy in "telephonic matters"? Is there no difference between "earth" and "metal." However, the whole question must be left to those pecuniarily interested. If they can see clearly how to make money by the exploitation of these patents we shall undoubtedly soon hear more of the subject, and then will be time to say what more may be said.

THE WALLER-MANVILLE SYSTEM OF ELECTRIC TRACTION.

We have received an explanatory pamphlet of this system to the following effect:

Electricity may be applied to the propulsion of tramcars in three ways: (*a*) From accumulators carried on the cars; (*b*) from overhead conductors; (*c*) from underground conductors laid in a conduit or tube beneath the road surface.

The system herein advocated belongs to the last-named class; and without instituting any comparison between the three systems, it may be stated that there are undoubtedly many cases in which a reliable conduit system would be desirable, and where neither of the other methods would be applicable.

Hitherto no conduit system has been introduced which has proved entirely satisfactory, and the following remarks in relation to such systems will indicate the nature of the defects referred to.

All conduit systems involve the laying of the conductors beneath the street level. Either contact is made through a slot in the road or, if a closed conduit is used, complicated apparatus must be provided for temporarily bringing a surface rail into circuit during the passage of the car over such rail.

The latter plan has never been brought into practical operation, and though such a system might be made to work on a small scale under favourable conditions, it is improbable that with the very unfavourable conditions of an ordinary road the indispensable complicated electrical devices, buried in the road at intervals of a few feet, could be relied on for constant satisfactory working. At any rate such a system would be very expensive both as regards first cost and maintenance.

In all "open" conduit systems hitherto tried or proposed the conductor is buried in the conduit, and cannot be got at without ripping open the conduit itself.

In some systems a bare rigid conductor is used, supported at necessarily short intervals by separators, the current being collected by means of a brush of some description dragged upon the conductor, and pressed thereon either by its own weight or by means of springs.

The disadvantages of such a system are these: (1) The conductors and separators have to be built into the tube during construction, and cannot afterwards be got at for the purpose of cleaning, repairing, or renewing, without ripping up the roadway. (2) The insulation is necessarily defective, as, with the frequent supports required, it is impossible within the limits of an ordinary conduit to provide proper insulators, and the small separators which are used become coated with damp and even with mud, causing an immense leakage of current. (3) The loosely-drawn collector frequently leaves the conductor, and it further necessitates the complication of points and crossi [illegible] e conductor itself.

In other systems of open conduit [illegible] is used, having bare contact points attached to it at intervals. A flexible band of some description (of a greater length than the distance between the contact points) is suspended from the car so as to be always in contact with one or more of these points.

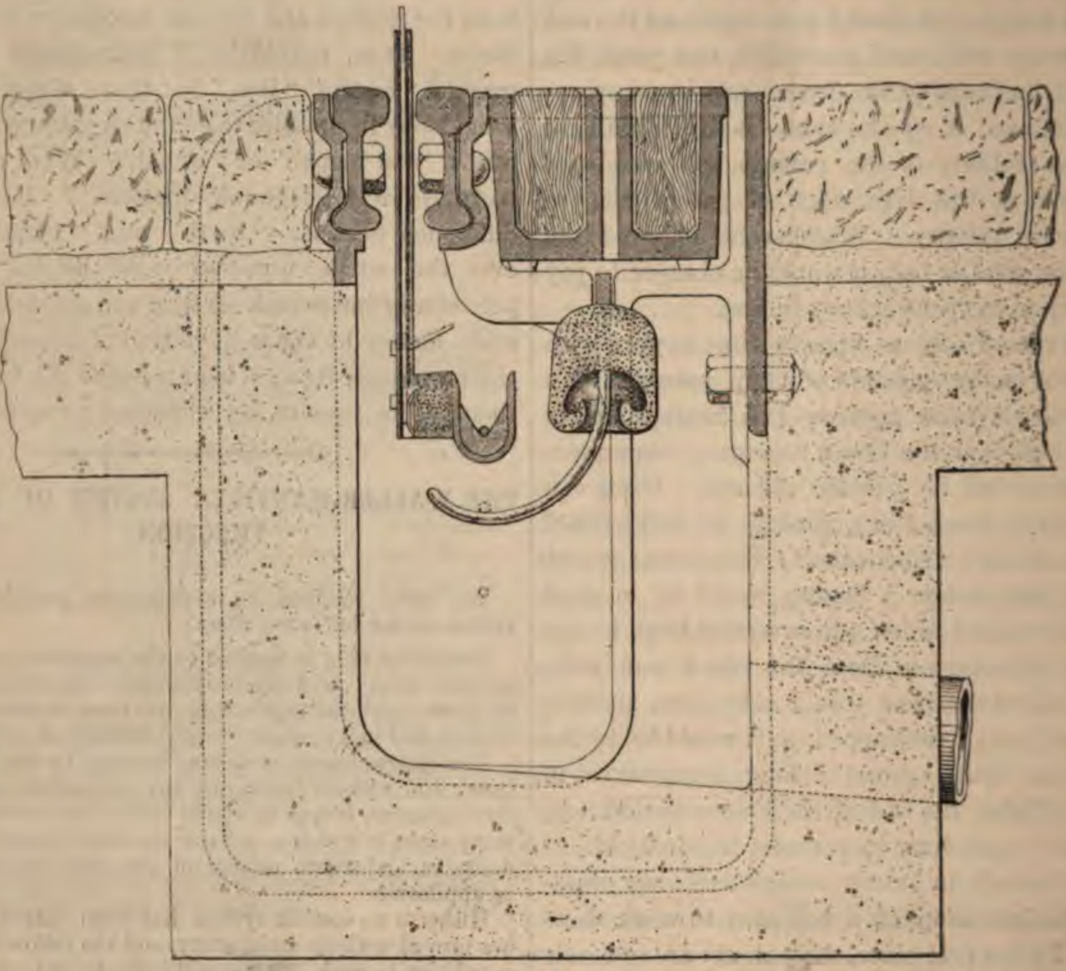

FIG. 1.

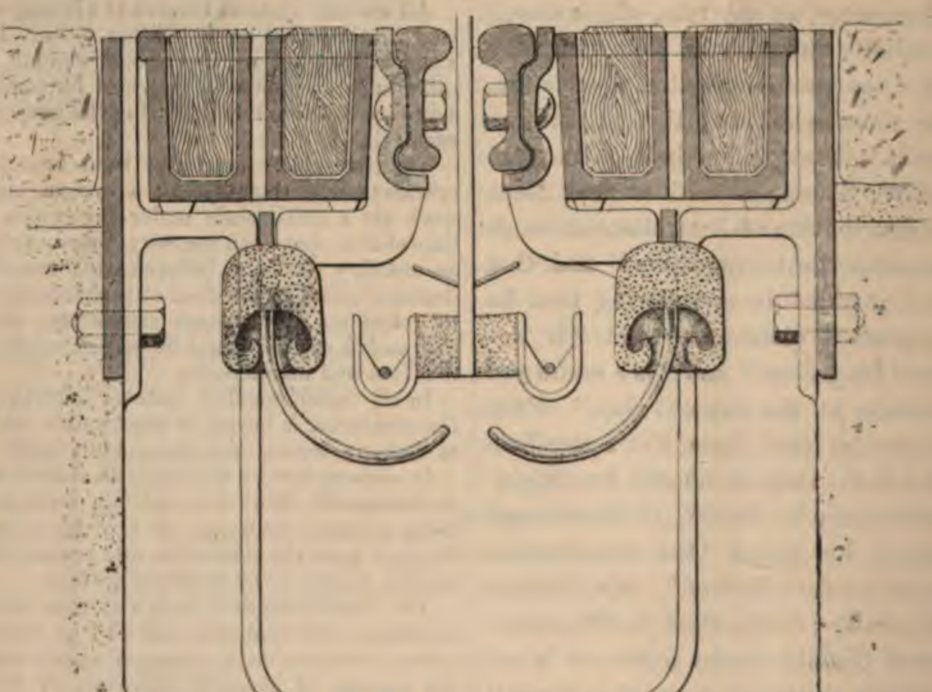

FIG. 2.

The same objections apply to this system as to that previously mentioned in regard to the conductor and its supports being built into the conduit, and also in regard to inefficient insulation. There is also a further danger introduced of the collecting band failing to engage with the contact points or striking the roof or walls of the conduit, as a loosely suspended band of this character cannot be made to travel with any great degree of accuracy.

A careful consideration of the foregoing defects has led to the conclusion that to ensure an absolutely reliable conduit system the following conditions must be fulfilled:

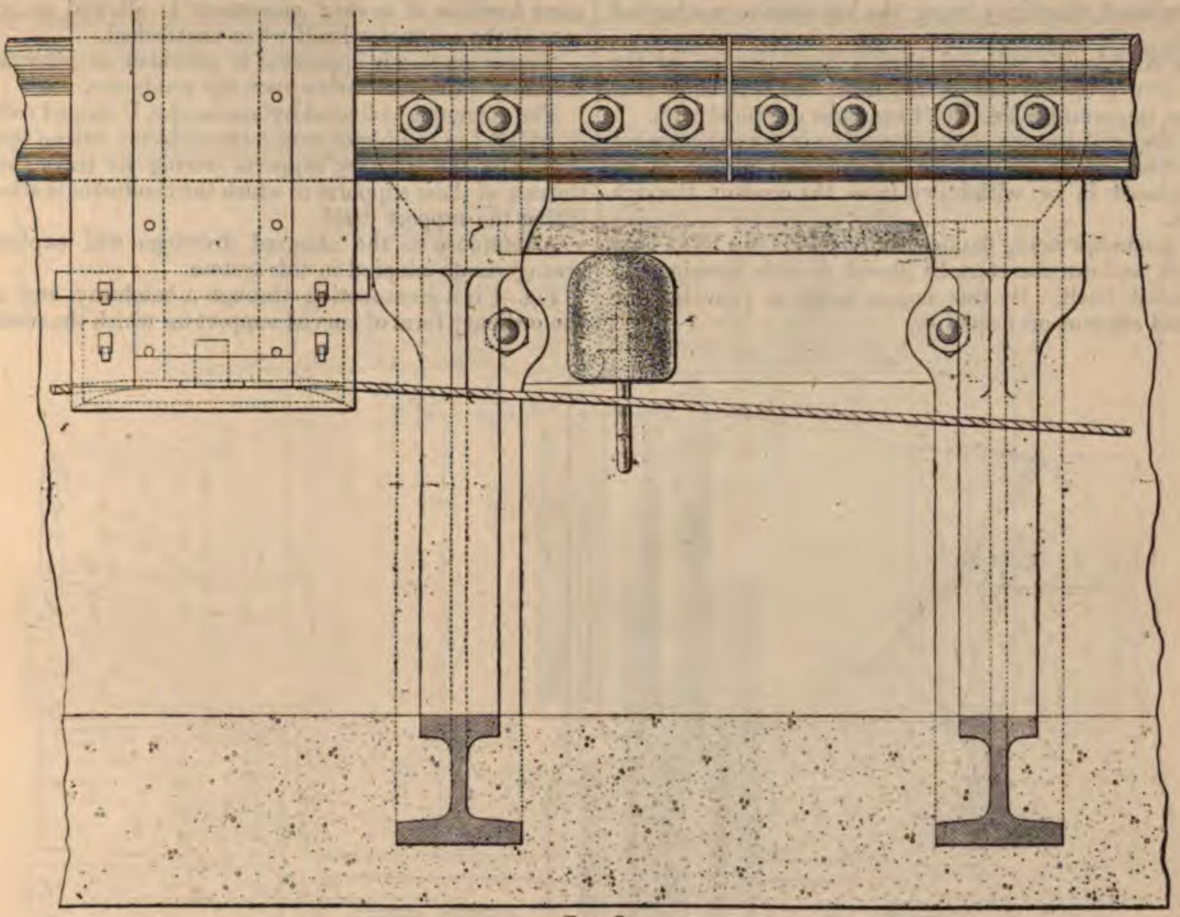

FIG. 3.

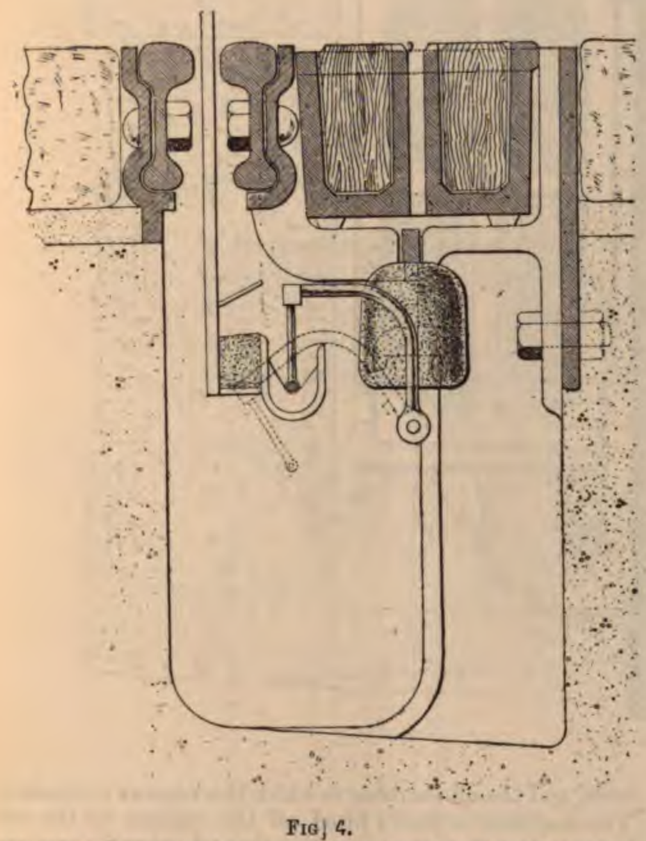

FIG. 4.

(1) All electrical fittings must be so designed that they can be placed in position, or removed for the purpose of renewal, without disturbing the road surface, and they must at all times be easy of access. (2) To ensure reliable insulation the supports should be as infrequent as possible, and, where requisite, they should be insulated from earth by means of efficient oil insulators. (3) Rigid collecting arms should be employed in order to ensure absolute accuracy of travel, to prevent any risk of contact being broken and to dispense with points and crossings on the conductor. (4) No complicated electrical or mechanical devices must

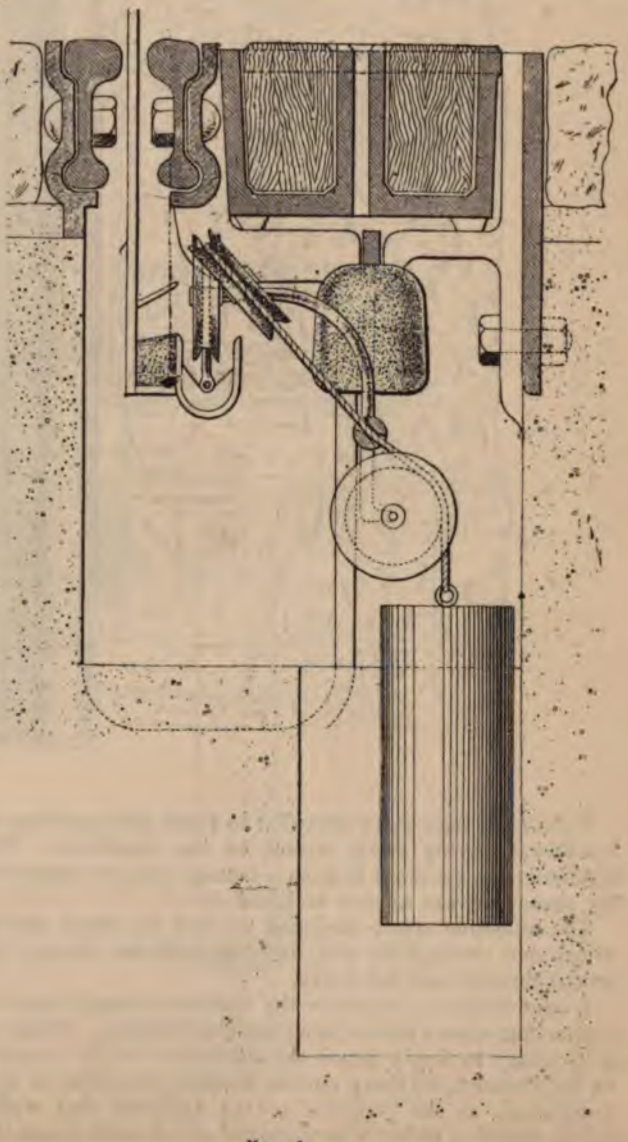

FIG. 6.

be introduced, simplicity being the key-note to mechanical success.

It is confidently believed that a consideration of the system now proposed and briefly described will show that all these important conditions have been complied with.

The essential feature of the invention is the employment of a flexible conductor sufficiently small to permit of its being placed in or withdrawn from the conduit through the slot.

The conductor being flexible, the supports can be at long intervals, and can therefore be placed in side openings to the conduit itself. By this means space is provided for large and efficient oil insulators.

Removable covers are provided to these side openings or hatchways, giving ready access to the insulators. The insulators are mounted in such a manner that on removing the cover they can at once be lifted out.

The collecting arm is designed so that the shank can be withdrawn through the slot, and the collector proper (or brush) through any hatchway.

Under ordinary conditions the conductor simply rests on supporting arms without being attached thereto. When it is necessary to firmly attach the conductor to its support, as, for instance, on sharp curves, absolute flexibility is still maintained, as the supports are so designed that whilst rigidly resisting either a longitudinal or a lateral strain, the same freedom of upward movement is allowed as in the case of the conductor itself when unattached.

Simple automatic apparatus is provided at intervals to maintain a constant strain upon the conductor.

The current is collected by means of a U-shaped collector in which the conductor runs; the collector lifting the conductor off the ordinary supports during its travel, and, in the case of those supports to which the conductor is attached, lifting the support itself.

A reference to the annexed drawings will explain the arrangements adopted in this system.

Fig. 1 is a cross-section through a hatchway, and shows the ordinary form of curved support on which the conductor rests, and the oil insulator to which this support is attached. The conductor is shown lifted off the support by the collector. Details of the connecting shoe, showing the arrangement for detaching it from the shank, are given in Figs. 1, 3, and 5.

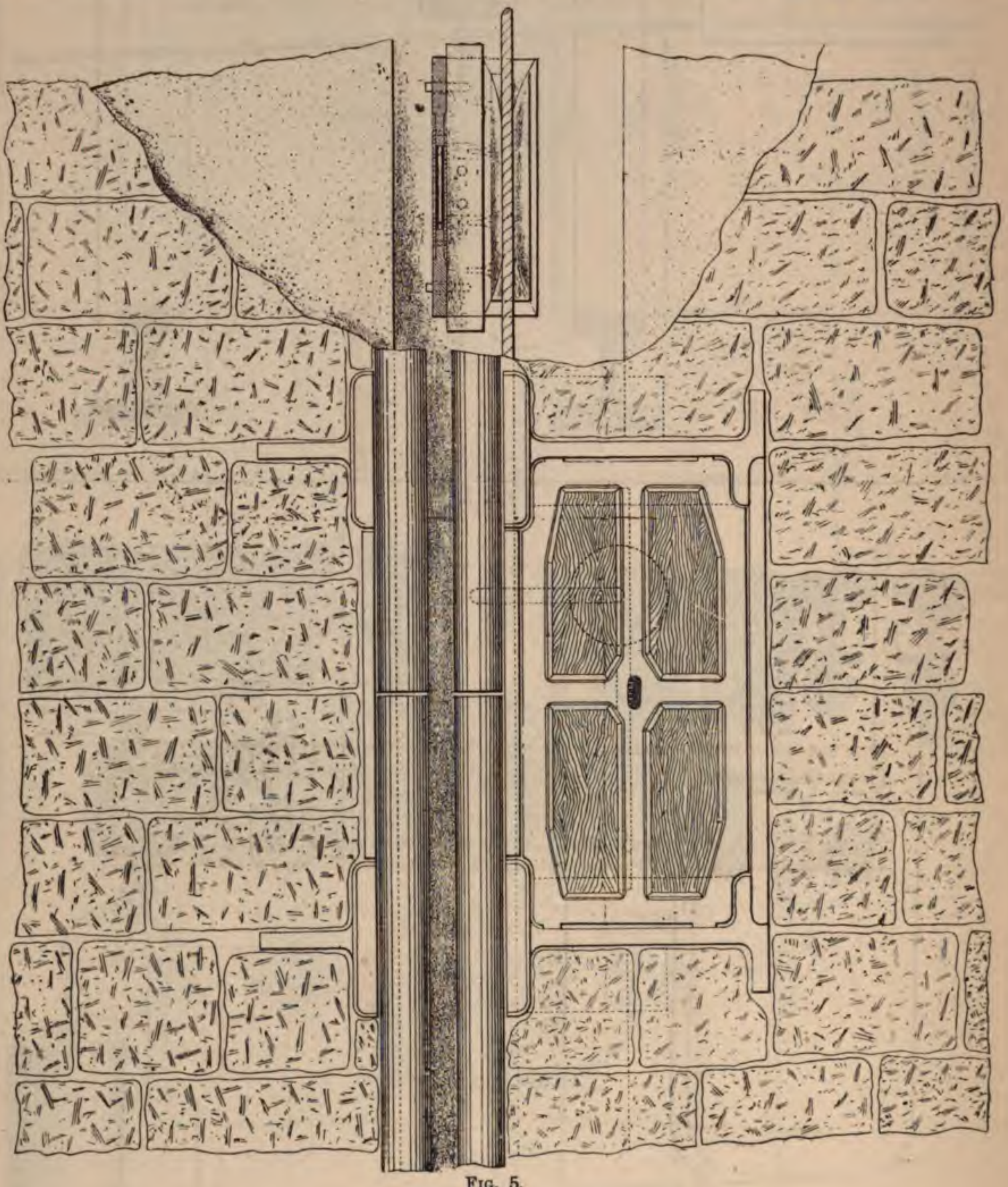
FIG. 5.

Fig. 2 is similar to Fig. 1, but shows the arrangement for two conductors in the tube.

Fig. 3 is a longitudinal section through the tube, giving a front view of the curved arm and a back view of the collector.

Figs. 4 and 8 give respectively a side and front elevation of a swivelling arm mounted on oil insulators. It will be observed that the conductor is held by this swivelling arm,

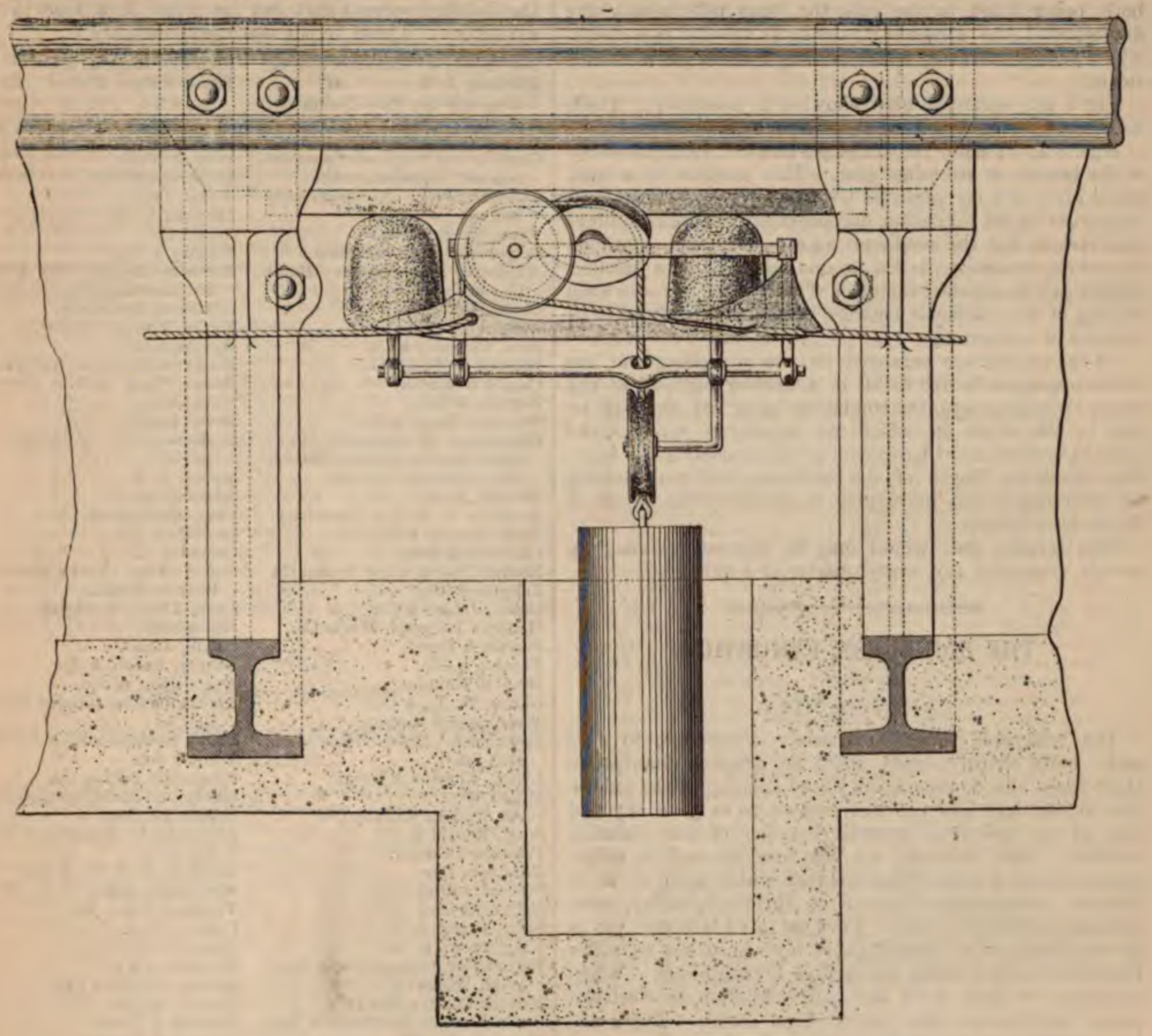

FIG. 7.

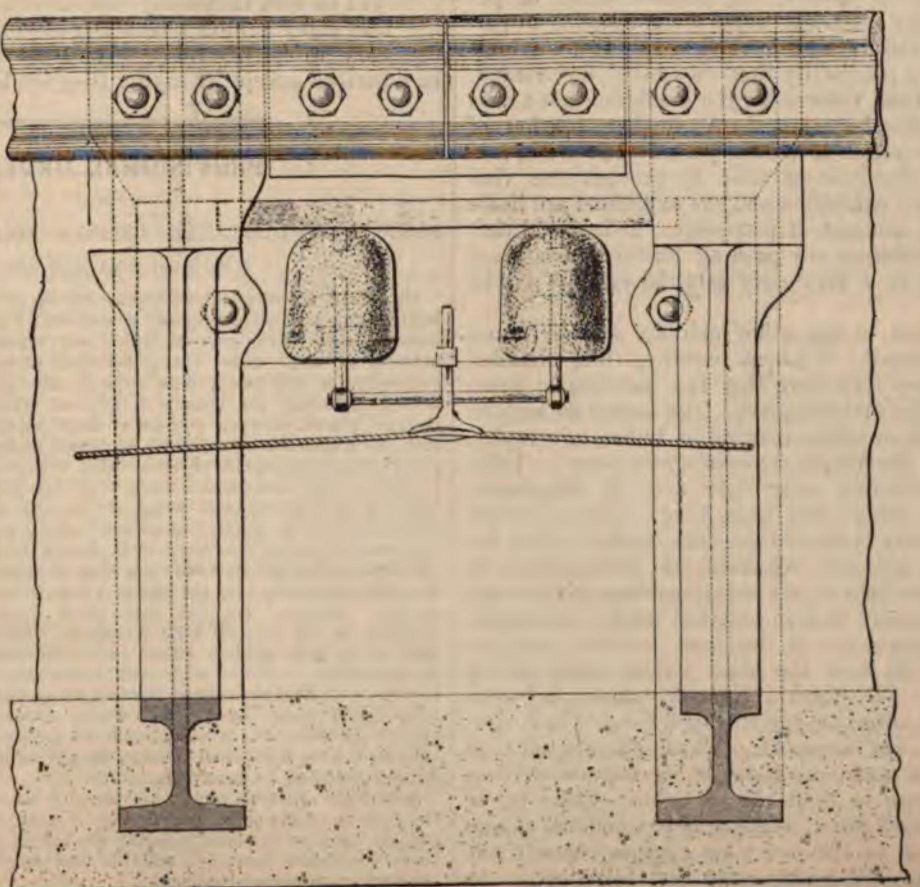

FIG. 8

both being lifted by the collector, thus maintaining the flexibility of the conductor as regards upward movement, while rigidly resisting either a longitudinal or a lateral strain.

Fig. 5 is a sectional plan showing a hatchway. These hatchways would be placed about 30ft. apart.

Figs. 6 and 7 show respectively a side and front elevation of the tension or straining gear. This consists of a gun-metal plate or yoke mounted on two swivelling arms and supported by oil insulators, and provided with small pulleys so arranged that the conductor, or cat-gut cord in continuation of the conductor, is led to one side, so that a balance-weight can be attached thereto. This weight serves to keep the sag of the conductor between its supports constant in all changes of temperature.

As the pulleys are arranged on the swivelling arm, the whole apparatus is free to lift in a similar manner to the single swivelling arm, the conductor being led through an eye in the shaft on which the apparatus revolves, the upward or downward movement of the tension frame in no way affects the length of the conductor, and consequently no resistance to this movement is caused by the weight of the counter-balance.

This tension gear would only be required at long intervals, occurring, say, every quarter of a mile.

THE EDINBURGH EXHIBITION.

I.—INTRODUCTORY.

The telegraph, though extremely convenient to give early news, hardly lends itself to graphic description, thus, while able to record the actual opening of the exhibition in our last issue, it was impossible to give any real idea of the value or general character of the electrical exhibits. This, however, we can now do, and in subsequent articles describe those exhibits which seem to us to deserve consideration because of their originality, completeness, or other reason. First, as to what is not yet in the exhibition, for Edinburgh, as elsewhere, has to suffer from the procrastinating proclivities of exhibitors. When complete, we shall have the best exhibition of electrical power distribution that has yet been shown. There will be a telpher line, a tram line, electrically driven boats, and machinery driven by motors. At present, steam or gas does the work the electrical motors are designed to perform. Why exhibitors who have determined to exhibit should be late, is a peculiarity that we cannot understand. A portion of the total visitors to the exhibition must miss seeing these interesting things. A further portion of intending visitors put off to a later period their visit, and in many cases circumstances arise to prevent the visit altogether, thus the exhibition and the exhibitors are liable to lose a certain amount of patronage. It is stated that these various exhibitors are pushing forward with great energy, and that at a very early date the exhibits will be complete.

The greater part of the other exhibits will be found in the machinery-hall. Without entering into detailed description, we may refer here to a few exhibits of great interest to electrical archæologists. The postal authorities exhibit in a frame an article relating to Indian telegraphy, printed in one of the Asiatic societies' *Proceedings* in 1839. This is an exceedingly early date even in telegraphic matters, and the article was news to us. Then, another archæologic curiosity is the old magneto machine, made for Prime and Sons by Mr. Woolrich, of Birmingham, in 1844. This is, we believe, the oldest machine in existence designed and actually used in practical work. An examination of this machine and of the most modern machines in juxtaposition will show the giant strides made during the half-century. Mr. Rankin Kennedy shows his most recent motor—an alternate-current motor—of which considerable things are expected. Then all around are dynamos. In the centre are Robey's big engines, driving the Brush machines to light the arc lights. Close by is Ruston and Proctor's stand, where a 25 h.p. nominal engine is running, similar to the two new engines recently put down at Taunton. But perhaps the best introduction to the detailed account that can be given is a mere list of exhibitors. These, in the machinery-hall, are :

Her Majesty's Postmaster-General
Hilditch, J. B.
Managers of the Watt Monument.
Eastern Telegraph Co.
Exchange Telegraph Co.
Consolidated Telephone Construction and Maintenance Co.
London and North-Western Railway Co.
Vavasour, Sir Wm.
Corporation of Birmingham.
Magnolia Anti-Friction Metal Co., of Great Britain.
Clark, Geo.
Blakeney & Rennie.
Ford, Galloway & Co.
Babcock & Wilcox Co.
Carrick & Ritchie.
Norman & Son.
Prentice, Napier & Co.
Description of Balanced High-Speed Engine, made by Easton and Anderson, Limited.
Hindley, E. S.
Institute of Medical Electricity.
Siebe, Gorman & Co.
Chadburn & Son.
Electric Date & Time Stamp Co.
Fairgrieve Bros.
Buller, Jobson & Co.
Henley's Telegraph Works Co.
Smythe & Payne.
Fleming & Co.
Davis & Timmins.
Glover, W. T., & Co.
Woodhouse & Rawson.
Macdonald, Right Hon. Jno. H.A., C.B.
Laing, Wharton & Down.
Miller, Wm.
Great Western Railway Co.
Scott, Ronald A.
Paterson & Cooper.
Priestman Bros.
Woodside Electric Co.
Miller, Richard
Scott, Ernest, & Co.
King, Brown & Co.
Indiarubber, Guttapercha & Telegraph Works Co.
Electric Construction Co.
Clark, Latimer, Muirhead & Co.
Hartnell, Wilson.
Kennedy, Rankin, & Co.
Edison-Swan United Electric Light Co.
Brush Electrical Engineering Co.
Höffler, W., & Co.
Poole & White.
Swinburne & Co.
White, James.
Zimdars, C. E.
Gent & Co.
Faraday & Son.
Northern Electric Wire & Cable Manufacturing Co.
Schäffer & Budenberg.
Fowler-Waring Cables Co.
Hutchison, G.
Murday's Electrical Syndicate.
Heriot Watt College (work of students).
Davis, David.
Roubanowitch, Woldemar de, Russia.
Müller, C. A.
Schuckert & Co.
King, Mendham & Co.
Lacombe & Co.
Conradty, C.
Cox-Walker's North-Eastern Electric Works.
Jooss, Albert, Stuttgart.
Bell & Sime.
Pitkin, James.
Bourne, Joseph, & Son.
Davis, John, & Son.
Elmore's Patent Copper Depositing Co.
Baird, Thompson & Co.
Tullis & Son.
Rossendale Belting Co.
Gandy Belt Manufacturing Co.
British Tanning Co.
Blackman Air Propeller & Ventilating Co.
Andrews, J. E. H., & Co.
Macdonald, John.
Turnbull, John, jun.
Crossley Bros.
Dick, Kerr & Co.
Hawthorns & Co.
Ruston, Proctor & Co.
Carlaid, David.
Fielding & Platt.
Saxby and Farmer.

It will be seen that many well-known names are wanting, that many exhibit interesting pieces of apparatus not necessary to be described, while some exhibits can hardly be described except by saying they are there.

PROVISIONAL ORDER.

FORM II.—UNDERTAKERS BEING A COMPANY OR PERSON.

(*Continued from page 355.*)

18. Where the undertakers require to dig or sink any trench for laying down or constructing any new electric lines (other than service lines) or other works near to which any sewer, drain, watercourse, defence, or work under the jurisdiction or control of the local authority, or any main, pipe, syphon, electric line, or other work belonging to any gas, electric supply, or water company has been lawfully placed, or where any gas or water company require to dig or sink any trench for laying down or constructing any new mains or pipes (other than service pipes) or other works near to which any lines or works of the undertakers have been lawfully placed, the undertakers or such gas or water company (as the case may be), in this section referred to as the "operators," shall, unless otherwise agreed between the parties interested, or in case of sudden emergency, give to the local authority, or to such gas, electric supply, or water company, or to the undertakers (as the case may be) in this section referred to as the "owners," not less than three days' notice before commencing to dig or sink such trench as aforesaid, and such owners shall be entitled by their officer to superintend the work, and the operators shall conform with such reasonable requirements as may from time to time be made by the owners or such officer for protecting from injury every such sewer, drain, watercourse, defence, pipe, syphon, electric line, or work, and for securing access thereto, and they shall also, if required to do so by the owners thereof, repair any damage that may be done thereto.

Where the operators find it necessary to undermine, but not alter the position of any pipe, electric line, or work, they shall temporarily support the same in position during the execution of their works, and before completion provide a suitable and proper foundation for the same where so undermined.

Where the operators (being the undertakers) lay any electric line, crossing, or liable to touch any mains, pipes, lines, or services belonging to any gas, electric supply, or water company, the conducting portion of such electric line shall be effectively insulated in a manner approved by the Board of Trade; and the undertakers shall not, except with the consent of the gas, electric supply, or water company, as the case may be, and of the Board of Trade, lay their electric lines so as to come into contact with any such mains, pipes, lines, or services, or except with the like consent, employ any such mains, pipes, lines, or services as conductors for the purposes of their supply of energy.

Any question or difference which may arise under this section shall be determined by arbitration.

If the operators make default in complying with any of the requirements or restrictions of this section, they shall make full compensation to all owners affected thereby for any loss, damage, penalty, or costs which they may incur by reason thereof; and in addition thereto they shall be liable to a penalty not exceeding £10 for every such default, and in the case of a continuing offence to a further penalty not exceeding £5 for every day after the first day during which such default continues, provided that the operators shall not be subject to any such penalty if the court having cognisance of the case shall be of opinion that the case was one of emergency, and that the operators complied with the requirements and restrictions of this section so far as was reasonable under the circumstances, or that the default in question was due to the fact that the operators were ignorant of the position of the sewer, drain, watercourse, defence, pipe, electric line, or work affected thereby, and that such ignorance was not owing to any negligence on the part of the operators.

For the purposes of this section the expression "gas company" shall mean any body or person lawfully supplying gas; the expression "water company" shall mean any body or person lawfully supplying water or water power; and the expression "electric supply company" shall mean any body or person supplying energy under the principal Act, but not under this order.

(To be continued).

LOCAL AUTHORITIES AND ELECTRIC LIGHTING.

The President of the Board of Trade, Sir Michael Hicks-Beach, M.P., on Friday, 2nd May, 1890, received a deputation from electric lighting companies respecting the clause in the model provisional order giving local authorities the power of absolute transfer of provisional orders under the Electric Lighting Acts.

Sir J. Puleston, M.P., in introducing the deputation, said he did not intend to take up much time in introducing the deputation, because they had among them a well-known authority on this question in which they were interested—Mr. Fletcher Moulton, who would put their case before Sir Michael. He would say, however, that they came there to the Board of Trade because they were sure of one thing: that the Board of Trade desired to facilitate, rather than to retard, the progress of electric lighting; and because in so believing they felt that after a fair consideration the Board of Trade would come to the conclusion that the fact of the clause being inserted in the model order would inevitably retard rather than promote the spread of this new industry. He might say at once that he had no personal interest in this matter, but he was inclined to take a general interest in it since the first Parliamentary Committee of 1882, of which he was a member; and he recollected that the question of delegation was one on which they stated their views very strongly. Under this Clause 60 of the model provisional order practically the local authorities would be able to, if they felt so disposed, sit upon the provisional order, and they could practically keep it, for the great interest local authorities invariably had in gas companies would considerably influence them in the direction. Indeed, in one or two cases of which he was aware, companies had been started under favourable auspices, but the gas company, by working the corporation, managed to throttle the new companies in these places. He believed that if they inserted the clause in the orders every town and every local authority in the country would apply for orders, as they would involve no responsibility whatever, and they would eventually get the orders and act apparently in the character of middlemen or traders. The last Act of 1888 provided for the longer tenure of 42 years, expressly for the benefit of private enterprises; but he considered if the powers proposed by this transfer clause were conceded to local authorities, they would be in a position to reduce the time as originally proposed to 21 years, by which means they would be reverting to the former condition of things, which would oblige the companies to put on a higher price for electricity consumed by customers, and would thus impede rather than promote the success of the enterprise. They did not wish to say anything derogatory to local authorities, but they were not immaculate, and were often adverse to the immediate development of electric lighting, which would prove a source of benefit to their constituent.

Mr. J. Fletcher Moulton, Q.C., speaking as one who had been intimately acquainted with what had been done in the matter of electric lighting, and one who had closely watched the whole of the proceedings both in Parliament and the Board of Trade, remarked that he wished very shortly to put before Sir Michael what seemed to him to have been the views of Parliament and of the Board of Trade during the development of electric lighting as to this most important question of transfer. Sir Michael would probably remember the Select Committee of 1882, before which the Electric Lighting Bill came, and the whole question of the transferring of provisional orders or licenses was considered very carefully, and he thought that the dominant feeling in the committee was that if their rights were granted by provisional orders or licenses, they should not be in the nature of concessions in which traffic could take place; that the power of supplying the electric light in a district was consistent with public duty, and was not a matter which should be handed from one person to another without the direct control of Parliament. Parliament also, he believed, thought it would be by no means a right thing to draw any wide distinction between companies and local authorities, although it was the opinion that local authorities stood in a different position with regard to supplying electric light and electrical power to the companies. He remembered it was most distinctly stated by the representative of the Board of Trade, and he could certainly say it came before the whole of the committee, that local authorities, if they came forward to ask for powers to distribute electricity, their intentions must be *bonâ fide*, there must be no "dog-in-the-manger" policy, and he might also say it should be their intention to immediately put it into effect. It was felt that the real question was whether the public ought to have the electric light, that the question of gas interest with the local authority was entirely a different matter, and that the public who had the electric light given to them should be protected even by the local authority themselves.

The **President** remarked that it was never intended that the objections of the local authority to any scheme should be overruled by the Board of Trade.

Mr. Moulton said he did not for one moment mean to say that the views of the local authority should be disregarded, for it had always been the custom to give the greatest weight to the wishes of the local authority, but it was never intended that the local authority should necessarily stop a company from supplying the public with the benefit of the electric light; and, further, it was not intended that the local authority should have powers if they did not mean to do the work.

The **President**: But if the local authority did nothing under their order in two years, they could revoke it.

Mr. Moulton, proceeding, said that in 1888 another committee was appointed by Parliament to consider the question of electric lighting as the thing had practically broken down, because the Electric Lighting Act allowed so short a period as 21 years in which the company would have to establish its works, get customers, make its profits, and provide for depreciation. Twenty-one years was too short, and the Act of 1888 dealing with this put down 42, which he thought a very reasonable number of years, but, at the same time, a clause was put in giving greater statutory weight to the position of the local authority Otherwise, he thought the Act of 1882 practically remained unchanged. Now, last year, he believed for the first time, at the application of one local authority, a clause was put in the order giving that local authority the power of transfer. That was, he believed, in the case of Swansea electric lighting. He did not know if that was any objection; he did not know if it was challenged. He only heard it quite recently, but the clause was put in.

The **President**: Powers have been inserted in the licenses of local authorities since 1884. Swansea was a provisional order.

Mr. Moulton: Licenses have been the means of only a very small portion of powers being granted. They are only for seven years, and can only be applicable for some experimental attempts, and they are not suitable for a substantial public supply. Some few have, however, been applied for by local authorities, but so far as companies are concerned, I do not think they have been much applied for.

The **President**: One company still holds a license, and the principle of transfer is the same.

Mr. Moulton: That may be so. I have not considered it. But with one exception, I do not remember any license of any importance in connection with companies. The question of this transfer clause being put into the orders has been before the companies, and I think the Board of Trade at the commencement of the year rather favoured its not being inserted, but there has been a discussion on the subject with the municipal authorities, and we understand it is going to be inserted in all provisional orders granted to local authorities. I will not deal with this point. I wish to show that it is unfavourable and contrary to the general Act, which overrides all provisional orders. I say that it is not within the power of a provisional order that it should be allowed to be transferred, without going to Parliament, from a local authority to a company, and I submit that it would be very detrimental to the interest of the public if this clause was inserted.

The **President**: The Act already enables the Board of Trade to sanction transfers.

Mr. Moulton said that this was quite different to the proposed clause, for whereas one provided for the transfer of certain portions of the order, the other gave the power of bodily transferring the whole of the provisional order. Mr. Moulton then read clause 4, which he said provided that no provisional order can authorise the supply of electricity unless notice has been given of such provisional order. But under the new clause it was different. The local authority might give the notice and might obtain the order. The local authority would be able to transfer the order to a company, and that provisional order would authorise that company to distribute electricity although the company had not given any notice. If this was to be the case, a body of middlemen would be created, and they would decide, not the Board of Trade, not Parliament, who were to be the undertakers. Mr. Moulton said of course the granting of a provisional order to local authorities was a step which Parliament regarded with very great favour, and the granting of an order to a company was one which Parliament looked into very carefully. He submitted that it was intended that powers for distributing electricity should not get into the hands of any company without this notice to the public, and that the provisional order was intended to mention the persons who were to be the people to have the direct supply.

The **President**: You submit that there should be no right of transfer at all?

Mr. Moulton: You already have the right to transfer by provisional order, but this clause provides for the right of bodily transferring the provisional order.

Sir John Puleston: It should be given subject to restrictions.

The **President**: There are very considerable restrictions in this proposed clause.

Mr. Moulton: We do not wish to get away from the Board of Trade—we have great confidence in the Board of Trade, but in a case like this we consider Parliament should be the power with whom the terms should be made.

The **President** stated that so far as the Board of Trade were concerned companies would get as much protection as before, but he supposed they were afraid of losing the protection of Parliament.

Mr. Moulton said they would lose the protection of Parliament, and he also believed in a measure they would lose the protection of the Board of Trade. They had heard of grave abuses by municipal corporations in other countries, but he hoped they would not have them in this country. Still he submitted it was necessary to consider this. Before any such rights are entrusted to a public authority with liberality, because it was a local authority, of handing it over to a private company he considered there should be a scouting of Parliament. Therefore he submitted that the clause not only went beyond what was meant by the Act, but it was organising a mode of dealings in concessions.

Mr. Henry Kimber, M.P., referring to the fact that the President had stated that they had the power of revoking an order after the lapse of two years when nothing was done under same, said that in the case of Brighton the Corporation had had the order for seven years, and had only just recently intimated the intention of undertaking the responsibilities of the order. He was quite sure that in some cases if the public had an opportunity of coming to the Board of Trade, the position of local authorities who had obtained powers under the Electric Lighting Act would be very different.

The **President** said that the local authorities were the elected representatives of the public. He did not look upon local authorities in the same light as private companies.

Mr. B. R. W. Williams said that Sir Michael would probably remember that last year he had an interview with him (Sir Michael), and he pointed out that in 1883 a great number of provisional orders was granted to corporations and also to private companies, and whereas in every case of the latter the orders had been revoked, not one of the orders of local authorities were revoked. He (Mr. Williams) pointed out the injustice of this, and, in reply, Sir Michael said that he looked upon them (local authorities) in a totally different light to supply companies.

The **President**: You are carrying my words rather further than I intended. I did not say I would not revoke any order of local authorities.

Sir John Puleston remarked that the real point was, they were desirous of promoting the science of electric lighting, and did not wish to see its progress impeded.

The **President**: I do not think it is the business of the Board of Trade to force the electric light on any town.

Sir J. Puleston: No; but to facilitate it.

The **President**: Ah! the two words have very much the same meaning in this sense. If the local authority would use the powers given them to keep the electric light out of its town, I should, of course, not allow that

Mr. Kimber: Then I hope you will hear anybody who could argue the facts of these cases.

The **President**: Yes, certainly.

Mr. Kimber: Then, how are they to get here?

The **President**: Simply come here.

Mr. Kimber: But you say, sir, that you cannot have the public here.

The **President**: I say it is not within my right to interfere with the public, because they have their own elected representatives.

Mr. Moulton was proceeding to refer to the question of spending the ratepayers' money, when

The **President**, interrupting, said: The question of obtaining the money is another point. The argument laid before me is that the local authority won't spend more, they will do nothing directly or indirectly in electric lighting. I think that you had better submit to me in writing your objections to this clause. Mr. Moulton has stated them very ably, and I should like to have them before me. I should particularly like to have your views as to the question of the terms. It could be argued that it is one thing for local authorities to do the work, to establish works of their own and then let them from time to time, but it is another thing to give over the concession for 21 years.

The deputation then thanked the President of the Board of Trade and withdrew.

NEW COMPANIES REGISTERED.

Electric Welding Company, Limited.—Registered by Ashurst, Morris, Crisp, and Co., 6, Old Jewry, E.C., with a capital of £460,000 in £10 shares. Object: to carry on business as manufacturers of and contractors for the sale, erection and maintenance of electric machinery which the Directors may think calculated to further the interests of the Company. The first subscribers are:

	Shares.
T. W. Meroon, 7, Nightingale-road, Clapton	1
W. Glynn, 14, Little Albany-street, Regent's Park	1
J. Kayler, 26, Ranelagh-terrace, Leytonstone	1
R. Gordon, Douglas Villa, New Malden	1
H. Tipple, 44, Elmsdale-road, Walthamstow	1
W. Doherty, 6, Great Newport-street, W.C.	1
W. H. Adams, 168, Friern-road, Dulwich	1

There shall not be less than three nor more than seven Directors; the first to be appointed by the subscribers to the memorandum of association. Qualification, £500. Remuneration to be determined in general meeting.

COMPANIES' MEETINGS.

HOUSE-TO-HOUSE ELECTRIC LIGHT SUPPLY COMPANY, LIMITED.

The second ordinary general meeting of the proprietors of the House-to-House Electric Light Supply Company, Limited, was held on Monday at the Central Electric Lighting Station (Kensington), Richmond-road, S.W., under the presidency of Mr. Henry Ramié Beeton.

The **Secretary** (Mr. H. St. John Winkworth) having read the notice convening the meeting,

The **Chairman** said: In accordance with the articles of association, the report and accounts have been issued to every shareholder, so that I shall probably be consulting the convenience of the meeting if I take them as read, and proceed at once to recommend them to your adoption. The first observation I have to make in regard to the accounts is, that the capital expenditure during the early stages of our business is necessarily out of proportion to the earning capacity; for the reason that, in the nature of the case, we are called upon to face a progressive demand, and that the most economical form of supply in the case of a small demand is different to that in the case of a large one, so that in the first instance we are practically obliged to adopt a capital basis which is adapted to an ulterior rather than an immediate revenue. The justification, therefore, of our accounts is to be sought at a point which is somewhat removed, and we must be content to-day if we are in a position to predicate with certainty the course of our profit in such a manner as to show that we are within measurable distance of a fair dividend, with the assurance of improvement in the future. Our existing plant is equal to the supply of twice as many lights, and our present capital capacity is equal to the supply of three times as many lights, as we have on our existing circuit, and this notwithstanding the fact that we have connected about 1,000 lights a month. This being the case, I think we are justified in congratulating ourselves upon satisfactory progress up to the present, and I think, also, that we may look forward to a steady progress in the future. It is at all times difficult to prophesy, and never more so than in a new industry in which the conditions are without precedent, and in which there is comparatively little experience available to guide us, but I can say with some degree of confidence that if the rate of progress which has prevailed in the past is maintained in the future, this time next year we should be in the enjoyment of a demand which will ensure us a good dividend on our capital, and in two years from to-day our profits should be as much as it would ever be prudent to distribute. We could, of course, have wished that our progress had been faster than it has been, but we find that even in a rich residential district like ours many causes operate to deter our custom. In the first place, it is our misfortune to suffer instead of profiting by the deficiencies of others engaged in the same line of business. It is unfortunately true that although we, have ourselves never had a failure of the light since we started, yet the fact that some of the more prominent of the supply companies elsewhere have notoriously blundered causes many people, even in our district, to hold off until such time as they can feel more assurance of continuous and reliable lighting. Then, again, the expense of installing the light operates against us with an added force during the life of existing gas fittings and during the unexpired term of short leases; and, lastly, we have been prejudiced by an entirely groundless apprehension, which has been fostered by interested and unscrupulous persons, of the danger of the electric current. But, notwithstanding these obstacles, we feel confidence in the growing favour of the electric light. It is healthful and it is clean, and these are benefits for which many can afford to pay, and which, when a sufficient demand enables us to reduce the cost of supply, we expect to be able to bring within the reach of more. As an indication of the confidence which is felt by our neighbours in our future, I may mention that every new building in the district, so far as we are aware, is being wired for the electric light, and no gaspipes are being admitted at all. Moreover, we are in a position to supply not only arc as well as incandescent lighting, but also motive power, and already among the business premises which we serve we have a demand for this class of custom. We hope that any inconvenience which you may have been at in coming here to-day is compensated for by the advantage of being able not only to visit our district, but also to inspect our station. I believe that whatever else may be said about us, everyone is prepared to recognise the excellence of our station, and, after all, mechanical efficiency is the root of prosperity in a business such as ours. Our dynamos, which I hope you will shortly see doing their work as they have done it from the commencement—noiselessly and with the minimum of supervision—have never needed repairs, and, indeed, no work has been spent upon them since they started. And this excellence of our work and the unrivalled experience of our engineers has induced us, not only to anticipate success in the fields of supply, but to look forward to erecting for others stations similar to the one which we have built for ourselves. We believe that those who are engaged in overcoming the daily difficulties of supply, and in constantly meeting the varying conditions of the industry, are the best qualified to undertake the work of construction. No engineer, whatever his theoretical attainments, and no construction company, however extensive its resources, can compete in the knowledge requisite to the successful establishment of a central station with those who, like the engineers of the House-to-House Company, have not only planned the first and most successful stations, but have conducted their working ever since. Possessed of these qualifications, and encouraged by the action of the Board of Trade in allotting the metropolitan area, we have formed provincial companies with a view to the development of electric lighting generally, and the promotion of the methods and interest of the House-to-House Company in particular, in other cities and towns in the United Kingdom. To this end we have appointed local agents, who have visited our works and acquired a knowledge of and a confidence in our system. These agents, acting on behalf of such provincial companies, have sought the permission of local authorities in all the chief centres to apply for statutory powers, and in so doing have neglected no opportunity of bringing the merits of our station under the personal observation of deputations from the local authorities. We hope and believe that the expenditure which we have incurred in this direction will bear good fruit, and in support of this expectation I may mention that we have already, in some cases, obtained the requisite sanction of the local authorities, and in others where such sanction has been withheld, we have reason to believe that, if the local authorities undertake the supply themselves, we shall be entrusted with the erection of their station, and if the local authorities neglect to apply for statutory power, we have the assurance of the Board of Trade, that in any application which we may make for a provisional order regard will be had to the fact that we have incurred considerable expense and complied with the rules of the department. With the growth of this branch of our business the Directors are of opinion that it will be desirable to make arrangements for the separation of supply on the one hand from engineering or construction on the other, and we have already had several plans under consideration to this end, as to which we shall report to the shareholders when the time arrives. With these few observations I beg to move: "That the report and accounts be received and adopted."

Mr. Robert Hammond (managing director): I have very much pleasure in seconding the resolution. I feel that after the very exhaustive speech the Chairman has made there is very little else to be said, but I should like to call the attention of the shareholders to one or two points in the report for the purpose of emphasising them. The first is that we have only for a very short time been in possession of parliamentary powers. It is true that our Company was formed two years ago, but it very soon became apparent, with the very stringent rules which the Board of Trade put forth with reference to overhead wires, that our system must be by underground lines, and though we made application to the Vestry in June, 1888, various forms had to be gone through before we could finally get what we really have got at the present time—an Act of Parliament. Practically, therefore, we did not start our station till November last, and I must say that I am inclined to take a very much more sanguine view of our recent progress than the Chairman has ventured to take. I fully emphasise what he says, and it would be absurd at the beginning of a 42 years' tenure under an Act of Parliament to judge of future business by the start of only a few paces that we have made upon it. For instance, glance at the map on the wall, which indicates the growth of the number of our installations from the beginning of November to the end of April. Well, it is fair to suppose that what has occurred here will go on much more rapidly as months pass by, and we may fairly say that, having arrived at a state of things by which we can claim that we have now got a revenue which covers all our working expenses and our establishment charges, we have done extremely well after practically six months' work, and at the outset of a career that will last for 42 years. The yellow line on the map represents the gradual increase of our supply of current from the station, going on through the dark months; and, when coming to the light months, not falling away, but being sustained by the increased business. I think a glance at that map shows very material progress, and I feel that at the end of the year we shall find that our present works are not sufficient to cope with the demand, and that, as foreshadowed in the report, we shall have to gradually, as business arises, increase our machinery. Going back to the formation of the Company, I would point out to the shareholders that we have absolutely carried out the programme which we originally laid down. Our Company was established for the purpose of founding supply stations. It was not established, as most electric companies are, for the purchase of patents—that was carefully avoided. We bound ourselves to no system, and the money which we asked for, and which was subscribed, has been used for the purpose of founding electric light stations. We first founded this station as a sample of the work that we are able to do, and then we prepared the ground for the founding of sub-companies, which in turn we hope will be subscribed for in the various districts, and which, again, will bring us a considerable amount of business, so that on all hands we are able to say that we have carried out the proposition with which we started. There is only one other point I should like to draw your attention to; it has not been alluded to by the Chairman, and I do not think it finds a place in the report. It is that not a single Director has received any fees during the establishment of the Company. It is not often that a report comes before shareholders in which no Directors' fees whatever appear, but it was felt by the Directors that until the business was thoroughly established they would not call upon the Company to pay the fees which, under the articles of association, are due to them. That seems to me to show that the very best interests of the Company are in the hands of the Directors, and, speaking as one who has been enthusiastic in the direction of electric supply from the beginning, and connected with the earliest electric stations, many of which are now working most successfully, such as those at Brighton and Eastbourne, I look forward with a great deal of confidence to the future of the House-to-House Electric Light Supply Company. I have much pleasure in seconding the resolution.

The resolution was then put to the meeting and carried unanimously.

Mr. J. Whitehead proposed the re-election of the retiring Directors (Mr. Henry R. Beeton and Mr. Robert Hammond).

Mr. Page seconded the resolution, which was unanimously agreed to.

The auditors (Messrs. Theobald Bros. and Miall) were also reappointed, on the motion of **Mr. Page**, seconded by **Mr. Whitehead**.

A vote of thanks was then accorded to the Chairman and Directors, and the proceedings terminated

CHINA AND JAPAN TELEPHONE COMPANY, LIMITED.

The seventh ordinary general meeting of this Company was held last week at the offices, Austinfriars. Mr. T. Lloyd presided, and in moving the adoption of the report, stated that the business of the Company was fairly progressing. They were able to carry forward a larger balance and to write off more for depreciation. The Hongkong exchange was now nearly self-supporting.

Mr. H. Grewing seconded the motion.

Mr. A. Little stated that in 1882 he sold the plant that he had purchased at Shanghai, and the goodwill, such as it was, for 937 fully-paid £1 shares. The transaction was settled by telegraph, and he did not know that there were other vendors who were receiving £17,000, a sum which he considered largely in excess of the value of the plant or of the goodwill. They had now been eight years without receiving any dividend, and he suggested for the consideration of the Directors whether the capital of the Company should not be written down to an amount which would represent the actual value of the plant at Shanghai and Hongkong. He would rather hold, for his own part, £400 of dividend-paying shares than his 900 shares on which he received no dividend.

The **Chairman** said that the suggestion should receive every consideration from the Directors.

The motion was then carried unanimously.

WEST INDIA AND PANAMA TELEGRAPH COMPANY, LIMITED.

The ordinary general meeting of this Company was held on Wednesday at Winchester-house, Old Broad-street.

Mr. C. W. Earle, who presided, said that the report of the Directors caused him some disappointment. He did not allude to the falling off in the traffic, which compared favourably with the largely-increased returns in the corresponding period of 1888, which also showed a considerable increase upon the traffic of the corresponding period of 1887. A year ago he was under the impression that what they had done, the large expenditure they had gone to, and the experience they had gained in the seas in which their cables lay, would have kept down the outlay upon repairs to cables. But the expenditure in the half-year under review had rather exceeded the average amount under this head. Up to December last they had had only four interruptions to their cables, but during that month they had experienced six, a fact which showed how impossible it would have been to do away with one of their two ships, a policy advocated at previous meetings by some of the shareholders. Owing to their having put down 77 miles of new cable, consequent upon repairs, which they had charged to revenue, the Directors had added nothing to the reserve fund, which now stood at what they calculated it would do last year. The colonies of Barbados and Demerara, which were served with single cables only, had made overtures to them for duplicating their lines, which the Board said they would be prepared to do if the respective Governments of these colonies would assure the Company of receiving their subsidies for a period of 10 years. After considerable negotiations, he believed that this proposal had been virtually agreed to, and they were now awaiting the text of the Acts which had been passed by the colonial Legislatures before proceeding with the new work. As he himself on a previous occasion had warned them, there was a danger looming before them in the shape of the French telegraph interests in the West Indies. It would be remembered that two years ago a French company had laid a cable to Venezuela. They would have welcomed that French company, or any other company, to those waters, provided it did not encroach upon their field of operations, which was not sufficient to support one, much less two, cables. The French company now proposed to lay another cable between the two French colonies Martinique and Gaudeloupe, which had hitherto been subsidising this Company to the extent of £2,000 each per annum. The subsidy of the latter had still several years to run; that of the former having expired at the end of last year. On this information reaching the ears of the French Colonial Minister he immediately sent out instructions ordering the Council General of the island to reassemble and reconsider their vote, as he had entered into a contract stipulating that the Martinique subsidy should go to the French enterprise from the beginning of the year, and the council immediately revoked the promise of the subsidy given to this Company. Having informed the meeting of his intention at the request of his colleagues and the three managing directors of the other companies, who had hitherto represented them at the international telegraph conferences, to be present at the forthcoming convention at Paris in the interests of the Company, he concluded by moving the adoption of the report, and the dividends recommended therein on the first and second preference shares.

Mr. William Ford seconded the motion, which was carried unanimously, and the retiring Directors and Auditor were afterwards re-elected.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY, LIMITED.

The thirty-third ordinary general meeting of this Company was held on Wednesday at the offices, Winchester-house, Old Broad-street.

Viscount Monck, who presided, stated that during the half-year they had paid a good dividend, they had largely increased the reserve fund, and they had paid off a large portion of the first issue of debentures. As regarded the current year, their income had so far been almost the same as that for the corresponding period of last year. When their concession expired they might be exposed to competition, but they could not prevent the Brazilian Government, or any else, from starting new competing lines. All that the Di could do was to exercise the greatest supervision in seeing that when the time arrived they might be in the best possible position for meeting any competition which might arise. He concluded by moving the adoption of the report.

Mr. Frederick Youle seconded the motion.

A short discussion followed, and, in answer to questions, the **Chairman** said he thought the dividend they had hitherto paid was not one of which the shareholders could fairly complain, and the Directors wished to retain in their own hands the right to increase the reserve fund to any point which they considered necessary. They might have to renew either of their cables, and the reserve fund might also become very useful hereafter for equalising the dividends and in connection with the subject of competition. The African Direct Company, in which they held an interest of £75,000, had brought traffic on their line in the past half-year amounting to £7,318. They would consider the suggestion whether larger purchases of their debentures could be made in the open market.

Mr. Thomas Fuller, the managing director, in answer to a question, stated that the monopoly they enjoyed under their Brazilian concession would expire in August, 1892, but they had the power to lay cables as long as they liked. The Portuguese concession would expire in January, 1895.

The motion was unanimously adopted.

SUBMARINE CABLES TRUST.

The nineteenth ordinary annual meeting of the certificate-holders in this Trust was held on Wednesday at Winchester-house, Old Broad-street, Sir John Pender presiding.

The **Chairman** said that the accounts which the Directors laid before them compared very favourably with those which were submitted at the last meeting. The revenue had amounted to £23,094, against £19,118 in the previous year. The expenses had been £1,274, as against £1,383. They were therefore some £4,000 better off than they were at the same time last year. As stated in the report, the certificate-holders had received interest at the rate of 6⅝ per cent. this year, compared with 5⅝ per cent. last year. They hoped to continue at the same or at a higher rate until they had liquidated the coupon which was now in arrear. They would then revert to the regular interest of 6 per cent., which, under their trust deed, was cumulative. He concluded by moving the adoption of the report.

The **Marquis of Tweeddale** seconded the motion, which was carried.

PROVISIONAL PATENTS, 1890.

APRIL 28.

6476. **Improvements in electrical batteries.** Henry Thomas Eager and Richard Philip Milburn, 433, Strand, London.

6490. **Electrical clockwork for pendulum time pieces.** Emil Schweizer, 28, Southampton-buildings, London. (Complete specification.)

6492. **Improvements in electric railways.** Mark Wesley Dewey, 45, Southampton-buildings, London. (Date applied for under Patents Act, 1883, Section 103, 2nd November, 1889, being date of application in United States.) (Complete specification.)

6493. **Method of electric refrigeration.** Mark Wesley Dewey, 45, Southampton-buildings, London. (Date applied for under Patents Act, 1883, Section 103, 15th November, 1889, being date of application in United States.) (Complete specification.)

6495. **Improvements in visual telegraphs.** Alexander Melville Clark, 53, Chancery-lane, London. (Sigmund Schuckert and Co., through Wirth and Co., Germany.)

APRIL 29.

6524. **An improved process for securing the better adhesion of metals when electrically deposited or coated.** William Ryland, 19, High-street, Sheffield.

6569. **Improvements in electrical measuring instruments.** Henry Harris Lake, 45, Southampton-buildings, London. (Edward Weston, United States.) (Complete specification.)

6581. **An improved method of repairing the carbon filaments of incandescence electric lamps.** Henry Harris Lake, 45, Southampton-buildings, Middlesex. (La Société L'Incandescence Electrique, France.) (Complete specification.)

APRIL 30.

6623. **Improvements in switches for controlling electric currents for lamps and other purposes.** Joseph Warden and George Smith, 66, Granville-street, Birmingham.

6632. **Improvements in or relating to electric igniting apparatus for gas and similar engines.** Robert Ménard, 323, High Holborn, London.

6667. **An electric meter.** Alphonse Frager, 28, Southampton-buildings, London.

MAY 1.

6726. **An electrical timepiece combined with installations for the distribution of electrical energy for lighting and other purposes.** Friedrich von Hefner-Alteneck, 28, Southampton-buildings, London.

MAY 2.

6793. **Combined electromagnetic coupling and brake apparatus.** Siemens Brothers and Co., Limited, 28, Southampton-buildings, London. (Firm of Siemens and Halske, Germany.)

6801. **Improvements in apparatus for testing leakage and insulation of electrical conductors.** Arthur Bromley Holmes, 6, Lord-street, Liverpool.

6795. **Improvements in secondary or electrical storage batteries.** Henry Edmunds, 47, Lincoln's-inn-fields, London.

6811. **Improvements in telephones.** William Vogel and Gary G. Calkins, 45, Southampton-buildings, London. (Complete specification.)

MAY 3.

6841. **Improvements in and connected with electrical fuse boxes, switch boxes, and similar electrical fittings.** Carrington Riddell Gordon Smythe and Ernest Payne, 140, Bath-street, Glasgow.

6865. **Electrical apparatus for automatically stopping the action of pumps when irregularities of working occur or for giving indications thereof.** Ernst Hartmann, 28, Southampton-buildings, London.

6878. **An improved electric alarm device for clocks.** Robert Schmitz, 151, Strand, London.

6893. **An improved galvanic element with constant current, applicable especially for producing incandescent light.** John Van Der Poppenburg, 142, Fleet-street, London. (Complete specification.)

SPECIFICATIONS PUBLISHED

1889.

8692. **Telephonic switches, &c.** Kingsbury (Western Electric Company). 8d.

9284. **Telephone circuits.** Burbank. 8d.

10801. **Electric lamps.** Pieper. 8d.

1890.

3787. **Electric railways.** Libbey. 8d.

CITY NOTES.

Direct Spanish Telegraph Company.—The traffic receipts for April were £2,089, against £1,867.

Venezuela Telephone and Electrical Appliances Company, Limited.—The letters of allotment in this company have been posted.

Eastern Telegraph Company.—The traffic receipts for April were £55,042, as against £51,452 for the same period of 1889, or an increase of £3,590.

Eastern Extension Telegraph Company.—The receipts for April amounted to £40,696, as against £42,709 in the corresponding period, showing a decrease of £2,013.

Cuba Submarine Telegraph Company.—The estimated receipts for April were £3,600, against £4,060. The receipts for January, estimated at £3,150, realised £3,176.

West India and Panama Company.—The estimated receipts for the half-month ended April 30th are £3,599, as compared with £3,402. The January receipts, estimated at £6,481, realised £6,557.

Great Northern Telegraph Company.—This Company's receipts for April were £21,600, making from January 1st a total of £81,800, against £84,000 and £85,200 for the corresponding months of 1889 and 1888.

Western and Brazilian Telegraph Company, Limited.—The report of this Company for the half-year ended December 31 states that the total earnings were £86,403, against £112,250, and the working expenses £40,391, against £31,220. The Directors recommend a dividend of 6s. per share, tax free, on the ordinary shares for the half-year, making with the dividend paid in November 4 per cent. for the year, leaving £3,248 to be carried forward. In the case of shares which have been divided into preferred and deferred, 1s. 6d. per share of the dividend now recommended will be payable to the preferred shareholders and 4s. 6d. per share to the deferred shareholders.

West Coast of America Telegraph Company, Limited.—The report for the year ending December 31 states that the gross income was £84,457, against £65,714. Adding £480 brought forward, and after deducting the debenture interest and all other charges, and the two dividends of 5s. each paid in July, 1889, and January, 1890, respectively, there remains £30,517. Out of this the Directors have transferred £25,000 to the reserve fund, bringing it up to £64,000, and they recommend the distribution of 2s. per share as bonus, payable on May 21, and the writing off of £2,000 from the value of the repairing steamer "Retriever," thereby reducing her valuation in the books to £15,000, leaving £517 to be carried forward. The traffic receipts of the Company for April amounted to £5,275.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Anglo-American Brush	—	2¼
— Pref.	—	1¾
India Rubber, Gutta Percha & Telegraph Co.	10	18
House-to-House	4½	5
Metropolitan Electric Supply	—	5¾
London Electric Supply	5	2½
Swan United	3½	5
Crompton & Co., Pref.	—	5½
National Telephone	5	5¼

NOTES.

France.—The town of Sétif has arranged with MM. Micon, Dumont et Nibelle, of Paris, for the lighting of the town with electricity.

Konigsberg.—An electric central station is to be erected at Konigsberg, for which purpose a vote of 1½ million marks is to be given.

Dividends.—About £1,000,000 is invested in electric light companies in Massachusetts. The total amount of dividends paid during the past year was £34,000, or 3½ per cent. on the total capital.

Swan and Edison.—We see it announced that the lawsuit between the Swan Company and the German Edison Company has been awarded in favour of the former before the German courts.

Unit of Self-Induction.—The N.Y. *Electrical Review* says with reference to the unit of self-induction: call it "Henry." If every American electrician accepts, foreign electricians will join them and the conference of 1892 will ratify the choice.

Sunderland.—At the last meeting of the Sunderland County Council, the town clerk reported that he had received an intimation that it was not proposed to proceed further with the order applied for by the Electric Lighting Company of Sunderland.

Sale of Plant.—A sale of electrical plant will take place at Bradford, on June 3rd and 4th, consisting of the dynamos, machinery, and tools of the Schmidt-Douglas Electric Works, Albion-court, Bradford. Further particulars will be found in the advertisement.

Eastern Cables.—The Eastern Extension, Australasia, and China Telegraph Company announce that the laying of their new Sydney-Nelson cable has been successfully completed, thus duplicating the cable communication between Australia and New Zealand.

Fareham.—The Fareham Local Board have passed a resolution to dispense with the gas on and after September 1st next, and to accept the offer of the Fareham Electric Lighting Company for lighting the town by electricity for three years, at a cost of £500 a year.

Bavaria.—The first central alternate-current transformer system in Bavaria was opened at Reichenhall on April 26. It has been erected by the Allgemeine Elektricitäts Gesellschaft from their branch at Munich. The railway station is to obtain its light from this station.

Manchester.—At the last meeting of the Manchester City Council, on the motion of Sir John Harwood, the Gas Committee were authorised finally to determine the area of supply to be laid down in the provisional order being applied for to provide for electric lighting.

The Electric Light at Sofia.—The Foreign Office have issued the following notice: "It is intended to light the town of Sofia, Bulgaria, with electricity, using the water of the Boyena as the origin of force. The cost of initial establishment is estimated at £20,000 to £24,000. Tenders will be invited in August."

A Sulphuric Ether Motor.—M. de Susini, a Corsican doctor, has, it is asserted, constructed a motive apparatus or propeller of 20 h.p., which is worked by sulphuric ether, a result which the doctor anticipates will realise a saving of 65 per cent. of the combustible material at present employed for setting machinery in motion.

Mexico.—The Department of Public Works has authorised Mr. Augustin Arriaga to build a standard-gauge railway, with telegraph and telephone lines, from Villa a Viezca, in the state of Coahuila, crossing the International Railway, and terminating at Villa de San Pedro, with power to extend the line to a connection with the Mexican Central Railway.

Adelaide Royal Agricultural Society.—We are informed that Messrs. Ransomes, Sims, and Jefferies, Ltd., of the Orwell Works, Ipswich, have been awarded the first prize for their portable steam engines, exhibited at this year's show of the above society. The report mentions, in addition, that the engine to which the award was made was very much admired for its construction and smoothness of working.

Birkenhead.—Alderman Willmer, at the last meeting of the Birkenhead Town Council, maintained it was to the interest of the public that the Corporation should make themselves complete masters of the situation, so that they could dictate terms upon which electric light should be introduced into the borough. He moved that, notwithstanding the numerous alterations made by the Board of Trade, it was desirable that the order should be proceeded with. This was carried.

Bridlington Quay.—The parish church of Bridlington (All Saints), in the Norman and Decorated style, is prettily situated; its chancel has a modern reredos of Ancaster stone, and the windows are of stained glass. In the gallery beneath the tower is an organ, which cost £1,500, connected by electric-pneumatic action with a keyboard in the chancel, and its case is beautified with silvered tin pipes and elegant tracery. The church is lighted by electricity, conveyed through wires from Thorpe Hall, the residence of A. W. M. Bosville, Esq., who at his own cost fitted this up.

An Impostor.—Our readers will do well to take notice of a fraud which has been carried out on Messrs. Woodhouse and Rawson. About a fortnight ago a number of electrical articles, bells, switches, etc., were obtained by a man of about 27, height 5ft. 9in., fair complexion and moustache, cast in one eye, and shabby appearance. An order was presented purporting to be from Mr. Honeywell, of Surbiton, and paid for by a cheque on the London and County Bank, Watford, which has been returned marked "no account." The list of articles taken is given in our advertisement columns.

Continuous-Current Transformers.—Our readers will be interested to learn that the first continuous-current transformer that has been installed for public supply has been erected in connection with the Chelsea Electric Station. The transformer is on Mr. Frank King's principle, and was immediately of use. The engines at the Court Theatre broken down and the Chelsea Company were applied for to supply current for the theatre from the mains, and owing to the use of the continuous current transformer the current was enabled to be laid on almost at a moment's notice.

King's College, London.—Through the munificence of Lady Siemens, an electrical engineering laboratory is being equipped at the above college, which will be known as the "William Siemens Laboratory." The laboratory will be thoroughly up to date, and through the kindness of Messrs. Davey, Paxman, and Co., of Colchester, the council have been enabled to equip a fine boiler and engine-room with all the machinery required to provide the necessary power. Dr. John Hopkinson, F.R.S., President of the

Institution of Electrical Engineers, has been appointed to fill the chair of electrical engineering.

Wrexham.—Upon a consultation being arranged at Wrexham between three members of the Corporation and three representatives of the Wrexham and District Electric Light Company, the time to be allowed at which the Corporation should be entitled to exercise its rights of compulsory purchase was fully discussed. The members of the Corporation finally agreed to recommend the Corporation to give the full period of 42 years. If the Town Council agreed to this, all the serious difficulty with the electric light company will be at an end, and it is to be hoped that work will be proceeded with at once.

Edison's Ore Reducer.—An interview with Mr. S. G. Burn, Mr. Edison's expert and manager in the South, settles the speculation concerning Mr. Edison's plans in the southern mining districts. It is now a well-known fact that Mr. Edison has for a long time been working on a process for the profitable reduction of auriferous sulphides, especially those of low grades. During the past autumn, having satisfied himself that he had solved the problem on a laboratory scale, he is now about to work upon the properties selected near Charlotte, North Carolina, and, if successful, will purchase them and set up works.

Colliery Signalling.—The Midland Counties Branch of the National Association of Colliery Managers met on May 3 at Messrs. John Davis and Sons' works, Derby, where a large amount of electrical apparatus for signalling, haulage, and light was exhibited. Mr. Davis, in the course of some remarks, thought it was safe to predict certificates of colliery managers would have to include electrical engineering. The system of Bloor's electric signalling was then explained by Mr. Ashforth and Mr. Winstanley Ellis. The meeting was adjourned in order to settle upon a suitable and effective code of signals for the neighbourhood.

Electric Lighting in Belgravia.—In the House of Commons on Monday, Sir M. Hicks-Beach, in answer to Mr. Leveson-Gower, said he was not prepared to interfere with the arrangements made in the metropolis last year for the supply of electrical energy until the companies to whom powers were granted had been allowed a reasonable time. He had been urged by the Vestry of St. George, Hanover-square, to grant a provisional order for another company to supply electrical energy in that parish. Two companies already possessed such powers, and he had informed them that he would not be disposed to support them another year unless they could prove that they were in a position to supply energy in the district.

"Bolton Evening News."—Messrs. Ernest Scott and Co., Close Works, Newcastle, have received the contract for lighting the new offices and printing works of the *Bolton Evening News*. The installation will consist of two 150-light "Tyne" compound-wound dynamos, fitted with heavy flywheels, to be driven from two 20 h.p. "Otto" gas-engines, which also drive the rest of the machinery. The installation will ultimately consist of 400 16-c.p. incandescent lamps, and the main and branch cables are to be put in for this number in the first instance, but 280 lamps only will be installed at the present time, the remainder of the lights to be added as required, when further dynamo power will be provided also. Messrs. Bradshaw and Gass, of Bolton, are the architects, and the work is being carried out under their supervision.

Electric Advertising.—A hint which might be taken by electric supply companies or a motor company, to be repeated wherever possible, is given in the following piece of news. One of the largest retail houses in Chicago has a Detroit motor in one of its front windows that, driven by current from an Edison dynamo, in turn drives a coffee mill and a spice mill used in grinding coffee or spices purchased by the customers. Judging from the number of passers-by that stop and watch the machinery in operation it is as good an attraction for the house as they could have, while the results actually secured by the motor company amount to no small sum. It is an excellent advertisement for both parties. Men who can make a good public advertisement out of it are the best persons to seek, for the first introductions of motors.

Central London Railway.—The Bill for this railway, the preamble of which was passed last week, came again before the Committee of the House of Commons for the settlement of clauses. A clause was inserted to provide for compensation in case of damage by reason of the removal of subsoil. The committee considered that the margin in the financial proposals of the company should be reduced from £979,000, as contained in the Bill, to £696,000, and a clause to this effect was inserted. A clause was also inserted to the effect that no prospectus should be issued to the public until the City and Southwark Subway had been working for three months. At the instance of the London County Council, it was decided by the committee to insert a clause stating that in the event of the company being requested by that body to set back any of their stations, the question as to the reasonableness or otherwise of the request should be settled by arbitration.

Loughborough.—The quarterly meeting of the Loughborough Town Council was signallised by the special attention of the mayor to the question of electric lighting of the town. He thought the time had come when the electric light must supersede the present system of lighting by gas, and especially was it desirable that the electric light should be adopted for buildings where a large number of people assembled together. Whether the time had really come for them to move in the matter was a question, he thought, for consideration. For his own part, he did not care how soon, so long as they could only fix upon the proper and best system. Whether they could proceed at once to use the electric light for their public buildings was a matter for serious consideration. In reply to a question by Mr. Morris, the Mayor said the Town Hall Committee would, he had no doubt, consider the question of lighting the town hall building before their work was completed.

Madame Tussaud's.—Madame Tussaud and Co. have instructed Mr. Gisbert Kapp to prepare plans and specifications for the electric lighting of their exhibition and the adjoining premises. These have been duly prepared and tenders invited, with the result that Messrs. Drake and Gorham are to carry out the work. The installation will be of interest specially on account of the precautions against risks of all kinds which have been taken. The use of soldered joints is almost entirely avoided to minimise fire risk and to obtain immunity from the complete extinction of light. The lamps have been arranged on three distinct circuits, two of which will be worked from the dynamos and batteries jointly, whilst the third will be worked from a separate battery, and is to serve as a panic circuit in case both of the others should be disabled at the same time. The installation comprises arc lamps and glow lamps, the latter in fittings specially designed to harmonise with the decorations of the various rooms.

Edinburgh.—It having been considered by some citizens that it is desirable to endeavour to carry out by local means the electric lighting of Edinburgh and Leith, a company called the Edinburgh Electric Supply Corporation, Limited, has been incorporated under the Companies' Acts, 1862 to 1866, with a capital of £100,000, in 20,000 shares of £5 each. The following gentlemen have consented to form the first board of directors: Sir Thomas Clark, Bart., Mr. Andrew Usher, of Northfield, Mr. Walter Berry, of Glenstriven, Mr. George Harrison, Mr. David A. Stevenson, C.E., Mr. D. Bruce Peebles, F.R.S.E., and Mr. Hugh Auld, W.S., and have issued a private circular requesting all who receive it to say if they will subscribe in the meantime for a minimum of five shares of £5 each, on the distinct understanding that they will not be called upon to take up these shares unless it is decided to proceed with the company, nor be liable for any expenses whatever in connection with the engagement.

Chelmsford.—At the monthly meeting of the Chelmsford Town Council the Lighting Committee recommended the Council to consent to the charge for private lighting by electricity being increased from 10d. to 1s. per unit, but if the total exceeds 50,000 units per annum the price be reduced to 10d.; that the street gas-lamp posts be taken down and stored away. The committee were perfectly satisfied with the electric lighting. The gas company had given notice to disconnect their mains from the aforesaid lamps, and the committee recommended that arrangements be made with the company to defer dealing with the connections on the principal roads until after the Agricultural Show, so as to avoid the inconvenience attendant upon breaking up the roads. The committee suggested that the County Council be approached with a view to erecting and their paying half the yearly cost of an arc lamp in front of the Shire Hall, which would take the place of the present two gas lamps (costing £13. 4s. 9d. per annum) and the gas for lighting the clock (£12 a year); the cost of erecting the column for the arc lamp would be £10, and the yearly cost £22. 10s., which would effect a saving. The report was adopted.

Artistic Lighting.—One of the prettiest exhibitions of artistic electric lighting it is possible to see publicly at the present time has just been opened at the art furnishing rooms of Messrs. Cooper and Co., of Great Pulteney-street, off Regent-street. The number of private installations in high-class houses is rapidly extending, and electrical engineers who have to do with the fitting up of artistic homes will see here carried out the soft, decorative effect which must be aimed at to bring out the full capabilities of the incandescent lamp. The exhibition consists of a set of rooms, all decoratively furnished in various styles and illuminated with fittings to correspond. In one room there is the rich luxuriousness of the Oriental mind, Persian filigreed work and variegated glass lanterns. In another we see the delicate white beauty of the Louis Quinze style of furniture, harmoniously lighted with twisted candlesticks, shaded with silk stuffs and laces. In a large centre room there is a magnificent chandelier of Venetian glass, with the lamp bulbs draped in orange and ruby silk, with laced shades. In corners we see statues carrying electric flambeaux, little flying cupids with their burden of light-giving bulbs. An Old English oak room is charmingly arranged as a dining-room, with the table laid out with delicate napery and roses, with silver electric candlesticks and roses suffused with warm light. The exhibition will remain open during May and June.

Deptford Trunk Mains.—The Highways Committee of the London County Council on May 6th reported that they had considered the notices of the London Electric Supply Corporation of intention to lay trunk mains in Crucifix-lane, and St. Thomas's-street, Horselydown; in Stamford-street, York-road, Sutton-street, and Belvedere-road; across Borough High-street and Blackfriars-road, and through Southwark-street, and Stamford-street. The trunk mains referred to in these notices were intended to convey a current at extra high pressure, and proper precautions would have to be taken for the protection of the public. The committee recommended: (*a*) That the sanction of the Council be given to the laying of the mains referred to in the notices (registered Nos. 58 to 61) dated 18th April, 1890, of the London Electric Supply Corporation, on condition that the mains be protected from external injury by a sufficient outer covering to the satisfaction of the engineer of the Council; that the mains in Southwark-street be laid in the subway and enclosed in iron pipe; that the positions to be occupied by the mains in the subway be subject to the approval of the engineer of the Council, and that the work of placing them be carried out to his satisfaction; and, further, that the company do give three days' notice to the Council's engineer before commencing the works in any of the streets referred to in the notices. (*b*) That the clerk be instructed to forward to the company a notice requiring it to lay the mains in Southwark-street, referred to in the notice dated 18th April, 1890, in the subway of that thoroughfare. These recommendations were approved.

Traction Cells.—It was recently stated by Mr. Frank Wynne that he had found it impossible to obtain traction cells from whatever source that would stand more than 200 dischargings. This rather startling assertion, made in a pamphlet advocating a different system, was certainly laid open to the idea that disparagement of accumulators in favour of conduits was the aim of this remark, and we objected to it at the time. We were more than surprised to find it also maintained by a well-known electrical engineer. It may be understood what such a thing would mean: for 200 chargings if used only once a day would mean the life of a battery for a tramcar of little over half a year; while if charged twice a day, as often would be the case, this would mean a life of one-fourth of a year, or a depreciation of 400 per cent. per annum. This seems utterly ridiculous from what is known and published on the behaviour of accumulators. But it was maintained that the data of people having to do with accumulators are persistently erroneous and misleading, and the truth with regard to storage is yet to be brought to light. These statements seem to require some investigation, and we therefore called upon Mr. Frank King, engineer to the Electric Construction Company, who now manufacture and supply the E.P.S. cells. Mr. King emphatically says that they have cells in practice which have given 450 dischargings. Even after this number of discharges the battery had only certain plates that required replacing, and the most part was in good condition. This is from actual work with traction cells, and there should be no difficulty in working the batteries for a year without repairs.

The Telegraph Congress.—The Telegraph Congress will open to-day in the Prince Imperial Riding House at the Louvre. One hundred and fourteen foreign delegates are expected. Of these 38 will represent the States in the Postal Union, and 23 different great companies. Canada, the United States, Mexico, and China will be unrepresented. M. Jules Roche, Minister of Commerce, will open the congress in a speech of welcome, and four French delegates will be present at all the sittings. The Minister will give a banquet, followed by a reception to the congress when its work is over. There will be two committees. One of these will discuss telegraphic tariffs and how to cheapen them, and the other international telegraphic rules. The votes will be by States, and not by delegates. It is understood that an attempt may possibly be made to somewhat restrict the use of code words for telegraph messages, which have become so important a feature in international mercantile operations. The council of the London Chamber of Commerce have unanimously supported and transmitted two influentially signed representations to the Postmaster-General and the Secretary of State for India, urging that the representatives both of this country and of the Government of India at the conference will strenuously resist all proposals that would have the effect of restricting in any way the use for code telegrams of all the legitimate words at present authorised. In a paper to be read before the conference it will be shown that in one year's working communication was interrupted 2,400 times on overhead wires; on the same number of underground lines interruption was only caused 400 times.

Telephony in the West.—The West of England Telephone Company certainly study the interests of their subscribers even when they themselves reap no pecuniary advantage. As was briefly announced at the Chamber of Commerce meeting on Tuesday, arrangements have been made by which all the principal Government offices at Devonport are placed in communication with the Telephone Exchange, and can be called up by the subscribers or from any of the call offices or from the Chamber of Commerce at any time during office hours. The Chamber of Commerce were negotiating with a view to such an arrangement when the Telephone Company stepped in and solved the difficulties by placing these offices on the Telephone Exchange without charge. The offices that will be thus connected are those of the Admiral's secretary's offices, Mount Wise; the General Commanding (private office); R.E. Office, Raglan Barracks; R.E. Office, Submarine Miners, Fisher's Nose; Main Guard; Signal Station, Mount Wise; secretary's, Admiralty House; Queen's Harbourmaster's Office; Admiral Superintendent's Office, Devonport Dockyard; and Keyham Dockyard. In addition to this any message on business during office hours will be received at the Secretary's Office, Admiralty House, and if deemed suitable will be transmitted by a signal to the various departments enumerated below: Her Majesty's ships, Picklecombe, Maker, Tregantle, Scraesdon, Crownhill, Bovisand, Staddon, Stamford forts, the Citadel, Hospital, Stoke; Gunwharf, Bull Point, R.N. Hospital, Royal William Victualling Yard, Drake's Island, and Breakwater. Messages for these, however, must be on public and urgent business. After the closing hours of the office, the office of the General-Commanding of the district will be switched through to the Telephone Exchange. Arrangements have been made by the Devonport Exchange not to put any one through to the Government House unless a message to the General is required.—*Western Morning News.*

Electric Tanning.—Is there anything in electric tanning, or is it, perhaps, another electric sugar business? were questions that were heard on several sides on Wednesday when a number of gentlemen, leather tanners, shareholders, and press representatives, went down to the British Tanning Company's works at Rothsay-street, Bermondsey. We think they all felt answered. A hide of leather was brought out for their special delectation from the large revolving butts, and was cut up in front of the onlookers. This hide, said Professor Crookes (who is one of the directors) was placed in the revolving butts 5½ days ago. All could see that it was well and thoroughly tanned, equal at least to that which had stood five or six months in the ordinary process. Pieces of this were cut off and handed round; other pieces that had been dried and rolled to be finished were cut up, and a piece can be seen at our office if desired—hard, strong, firm shoe leather, and produced in five to six days instead of six to eight months. The process consists in simply placing the hides after cleaning into the large revolving wooden butt, with water and a known proportion of tannin. These butts are revolved by the engine which drives the dynamo, in this case a Paterson and Cooper dynamo. A thick copper wire is simply led round the interior of the huge drum-shaped butt, and at the opposite side another wire constitutes the other pole. The skins splash about pell-mell in the liquor as the drum revolves slowly. A current of about 10 amperes at 70 volts passes the first half of the period or so, about two days more or less according to the skins. In the ordinary course the tannin tans the outer surfaces of the skin, forming an almost impermeable surface which very slowly penetrates to the centre. In the new process the current causes diffusion, the tannin is taken up quickly, and the leather is thoroughly tanned in the short space of time mentioned. The formation of gas in the interior of the pores may also have something to do with it, and the heat generated also no doubt aids the process, but that it is successful is beyond doubt, and the men who have been on this kind of work for years are astonished beyond measure at the fine appearance of the leather after so extremely short an immersion. The leather is beginning to be sold in the market, and, although opposition is encountered from old-fashioned leather merchants, it no doubt will take its place and prove to be another of the triumphs of electrical treatment.

Mordey Alternate Motors.—Mr. Mordey has been twitted quite undeservedly with claiming priority in what others have already done—namely, the running of alternate dynamos in parallel. Such an idea is based upon a misapprehension. What Mr. Mordey pointed out was that alternate-current dynamos could be run in parallel without the necessity for large self-induction and resistance, which was maintained by Forbes, Hopkinson, Kapp, Swinburne, and others, to be a necessary concomitant. They acknowledged these would be an evil in other respects, and what Mr. Mordey stated and proved was that they were unnecessary in parallel running, and in this he has certainly priority. Previous work was very fully referred to in his paper (*Journal*, Institution of Electrical Engineers, xviii., 584-5). He quoted opinions by such authorities as Forbes and Kapp, expressed within a few weeks of the reading of his paper, that the qualities necessary to secure successful parallel working were the qualities that on every other ground should be avoided. The position he took then is still unaltered, and the running of Mordey dynamos as alternate motors requires nothing but the demand to become quite as usual an occurrence as the installation of an alternating dynamo. From time to time experiments have been made to demonstrate the practicability of such a course. Quite recently Mr. Mordey has tested a 33 h.p. alternator running as a motor, and has attained 33 actual h.p. from it at a high efficiency. Another experiment showed that a 160 h.p. alternator running free as a motor absorbed only 4 h.p. to excite and drive it and its exciter. The only difficulty to be overcome in running these alternate-current motors is the starting, and this is really no difficulty, for a battery of eight storage cells giving some 5 h.p. will bring the motor up to speed in five minutes, while it must be remembered that the ordinary large mill engine will usually require more than a quarter of an hour to attain full speed from the time when steam is first turned on. For a steady load, such as driving a mill would be, the action of the alternator is perfect. Although no alternate motor plants have as yet been put down, Mr. Mordey states that the Brush Company is ready to put down alternate motor plants for steady work, such as factory running, where water or other power is available, and to guarantee proper working and a high efficiency. It is to be hoped that some engineer or mill owner who requires to work at a distance from some available power, will take up the question and install such a motor for his works, so that we may have the satisfaction of seeing large alternate motor plants becoming practical in England.

The Telautograph an English Invention.—Statements have appeared from time to time in British newspapers and technical journals with reference to the auto-telegraph or telautograph, one of the latest developments of electrical science, which ascribes its origin to an American inventor, Prof. Gray. This wonderful instrument, which is to solve the question of sending autograph messages, drawings, and plans by telegraphy, has just been proved to be of British origin in a case that has been decided before the Comptroller of Patents. The principle of the auto-telegraph consists in actuating the receiving instrument by means of transient electric currents or pulsations produced at the transmitting instrument by the movement of a pen, and transmitted through the line wires, which currents are utilised at the receiving station to actuate electromagnets or motors, which move the writing pen. For this invention a patent was applied for by Mr. Thomas O'Brien, of Liverpool, on May 30, 1888, and by Prof. Gray, of Highland Park, U.S.A., on July 31 in the same year, so that the English inventor has priority of two months. A patent was duly granted to Mr. O'Brien for all the main features of the instruments, and he opposed the granting of the patent applied for by Prof. Gray, on the ground that the same invention had already been patented to him. After considerable delay on the part of the American, the case was eventually set down for hearing, and the Comptroller of Patents has decided that the two inventions are practically the same, and has refused to grant a patent to Prof. Gray unless he withdraws his principal claim and inserts a disclaiming clause in the specification to the effect that his patent does not claim or cover anything that is described in the specification of Mr. O'Brien's patent. Thus his patent, if granted at all, will refer only to minor details of construction, which are of but slight importance. This decision will also have the effect of establishing Mr. O'Brien's rights in the patents granted in foreign countries. Messrs. W. P. Thompson and Co., patent agents, of Manchester, Liverpool, and London, appeared in support of Mr. O'Brien's patent, and Mr. Newton, of London, appeared for Mr. Gray. It is open to Mr. Gray to appeal against this decision if he be so advised, and it remains to be seen what course he will adopt. Mr. O'Brien has now had working instruments prepared, and of these the public will probably hear more shortly, as they are to be exhibited in London in the course of a month or so. It is to be hoped that now the question of priority is settled the parties will not waste their time and energies in further litigation, but rather that, if necessary, in the public interest they will amalgamate, so that the community may have the full advantage of the invention as early as possible.

Technical Education.—Dr. Frankland, on May 7th, read a paper on "Higher Technical Education" before the Society of Arts, which is printed in the *Journal* of the society just issued. The position of England as regards technical schools was specially dealt with in comparison with Germany and Switzerland, which countries Dr. Frankland had visited last year. In addition to twenty-one universities, Germany possesses nine technical high schools or polytechnics, Berlin and Munich possessing both. Switzerland has, in addition to four universities, one polytechnic for the whole Republic at Zurich. These polytechnics limit their teaching to subjects connected with arts and manufactures, offering a programme of practical work impossible to find elsewhere. Dr. Frankland contrasts the soot-encrusted walls of University and King's Colleges, the "Lancashire cotton-mill," known as the Central Institution, which are the most striking institutions in which the higher education of London is carried on, with those of the smaller towns of Germany. Six towns—such as Hanover with 85,000 inhabitants, and Darmstadt with 48,000, and Carlsruhe with 52,000—with a total population of 100,000, have each a fully-equipped polytechnical school, any one of which would put to shame the equipment of any institution with at all similar aims in the United Kingdom. He gives the very comprehensive list of subjects for study in an architectural four years' course, carried on by twenty-two professors and assistants in this one department, the whole teaching staff numbering sixty-eight professors and assistants. The number of students is 504, of these 412 following the course in one or other department in its entirety. Some interesting particulars are given of Zurich Polytechnic. Here 638 students attend, less than half, 261, being Swiss. Students come from all countries—Turkey, Sweden, Spain, America. Russia sends 104, Great Britain seems but little to appreciate the advantages of Zurich, as only seven are British students. The annual expenditure is £25,743 at Zurich. In these institutions the academical style of instruction is given, classes for manual instruction not being often found. Germany has other trade schools in which trade processes are taught very completely, arranged with museums and actual machinery. Of these one of the most remarkable is that at Crefeld, devoted to all branches of textile manufactures. Dr. Frankland's visit to this was a disappointment and annoyance, as he was referred to the directorate, and treated as if he were the emissary of some English firm endeavouring to appropriate trade secrets. He managed, however, to inspect the museum and some of the products of the school itself, and testifies to their being a brilliant testimonial of the practical and serious work done in the school. This school was started in a small way, was fostered by the Crefeld Chamber of Commerce, and from 1883 five-eighths of its cost was defrayed by the State, and the remainder by voluntary contributions, chiefly in Crefeld itself. Corresponding with the magnificent State-supported technical universities of the Continent, we have various local colleges endowed [illegible] and towards which the shabb[illegible] difficulty, been wru[illegible]

THE EDINBURGH EXHIBITION.—II.

We pointed out last week that many of the exhibitors were behind in arranging their stalls. The work is being pushed on rapidly now, but before describing in detail the purely electrical exhibits we have thought it best to give in this and the next article a general description of the electrical part of the exhibition; of the motive power used; of the distribution of the arc light and incandescent light, both in the grounds and throughout the buildings.

Speaking generally, the ground of the exhibition may be said to be a square of an irregular shape, with the longest diagonal pointing due north. The Caledonian Railway bounds it on the north, and the Union Canal and tramway system bound it on the south. The suburban railway of the North British Railway Company runs right through the ground, dividing it into almost two equal portions. The portion of the building lying to the east has an approximate area of 1,100ft. by 900ft., and the portion lying to the west has an area of about 1,400ft. by 900ft. The eastern portion contains picture galleries, music hall, women's industries section, courts for the foreign countries, Italy, Austria, Russia, Germany, etc. Of these exhibits no further notice will be taken in these articles.

A covered bridge across the suburban railway connects the North Court in the eastern portion to the Machinery Hall in the western portion. The Machinery Hall is 700ft. long by 150ft. broad, giving an area of 105,000 square feet. Along the north side of the west half of the Machinery Hall is the Railway Court, 300ft. long. Here are exhibits by the London and North-Western Railway Company, the North-Eastern Railway Company, the Caledonian Railway Company, the Great Northern Railway Company, also a full-sized model of Stephenson's "Rocket," "Wylam Dilly," "Lord of the Isles," etc.

The "Wylam Dilly" was constructed by Blackett and Hedley, in 1814, for the purpose of working the coal trains at the Wylam Collieries.

Stephenson's "Rocket" was constructed by George Stephenson in 1829, and on trial attained a speed of 30 miles an hour, with a single carriage, containing 30 passengers, attached to it.

"No. 1 Locomotion," also constructed by George Stephenson, in 1825, is said to have attained a speed of 15 miles an hour, with a load of 90 tons, at the opening of the Stockton and Darlington Railway on the 27th September of that year. The "Lord of the Isles," built in 1851 from the designs of Sir (then Mr.) Daniel Gooch, was exhibited at the great International Exhibition of that year. It is said to have since run about 800,000 miles. Symington's marine engine, "Charlotte Dundas," constructed in 1802, was the first attempt at a marine engine. It worked paddles, and from it Fulton took his idea for steamers in America. The visitor should compare these antiquities with the huge specimens of engineering skill exhibited by the London and North-Western Railway Company and the North-Eastern Railway Company, each showing a specimen of their modern passenger-train engine and tender, with a saloon carriage attached, occupying a space of 110ft. long by 10ft. broad.

At the end of the Railway Court is the boiler-shed. Here are put up five of Galloway's Lancashire boilers, supplying steam to the engines in the hall by two large pipes, one of which is in reserve. The combined capacity of the boilers is about 2,500 h.p., and the pressure at which the steam is supplied is about 110lb. per square inch.

In the centre of the Machinery Hall is the Dynamo Court. It is 120ft. long and 80ft. broad. It is railed in with passages, 20ft. wide, for the public all round. The engines of Robey and Co., of Lincoln, are used for driving the dynamos for all the arc lamps used in lighting the exhibition buildings and grounds. They are seven in number.

1. Coupled compound horizontal engine, capable of working up to 350 h.p., fitted with Richardson's and Rowland's patent automatic trip expansion gear and governor, for securing the utmost economy in steam and regularity in running; cylinders, 18¼in. and 30in. diameter, 40in. stroke, 65 revolutions per minute; flywheel, 15ft. diameter; grooved for 12 ropes, 1¾in. diameter.

2. Compound horizontal engine, capable of working up to 260 h.p.; also fitted with trip expansion gear and governor; cylinders, 15in. and 26in. diameter; 86 revolutions per minute; flywheel, 12ft. diameter; grooved for nine ropes, 1¾in.

3. 25 h.p. (nominal), compound Robey fixed engine, capable of working up to 100 h.p. Cylinders, 9½in. and 16½in. diameter, 18in. stroke, 143 revolutions per minute; flywheel, 8ft. 11½in. diameter.

4. High-speed compound horizontal engine, capable of working up to 28 h.p. Cylinders, 5¼in. and 9in. diameter and 6in. stroke; flywheel, 3ft. 6in. diameter; 300 revolutions per minute.

5 and 6. Two each 8 h.p. (nominal) vertical engines, capable of working up to 32 h.p., coupled with flywheel 7ft. diameter in centre (between engines), cylinders 9½in., diameter, 12in. stroke, 135 revolutions per minute.

7. One high-speed vertical engine, capable of working up to 44 h.p., cylinder 10½in. diameter, 10in. stroke, 285 revolutions per minute, flywheel 4ft. 6in. diameter.

There are, in addition, two Westinghouse engines, specially constructed for the occasion by Messrs. Alley and Maclellan, of Glasgow, one of them being of a novel design. It is on the triple expansion principle, and an unusual degree of economy is expected of its working. These two engines are used in connection with the incandescent lighting of the Grand Concert Hall.

For the transmission of power to the different parts of the hall, the shafting, which is made of lengths coupled by adjustable loose collars, is entirely of steel. That in the Dynamo Court makes 230 revolutions per minute, and is 4½in. in diameter. That in the Machinery Hall proper makes 180 revolutions per minute, and is 3in. in diameter.

We shall refer to the systems of arc lighting and incandescent lighting in our next issue.

ON THE HEATING EFFECTS OF ELECTRIC CURRENTS.*

BY WILLIAM HENRY PREECE, F.R.S.

The effects of the heat developed in conductors when electric currents are transmitted through them have been the subject of constant investigation on my part since 1878. In 1880 I found that the rapidity with which small bare wires acquired higher temperatures and lost them in air was so great that it was possible to reproduce sound and speech by means of the thermo-telephone (Roy. Soc. *Proc.*, No. 204, 1880).

I determined subsequently (Roy. Soc. *Proc.*, No. 231, 1884) the current that raised the temperature of small conductors in air to the fusing point, and proved experimentally that, while bare cylindrical wires of very small diameter did not follow the $d^{\frac{3}{2}}$ law, this law became rigid for all diameters above 1 mm.

Papers Roy. Soc. *Proc.*, November 24th, 1887, and March 15th, 1888, dealt principally with the fusing points, and the following table, to which I have added silver, gives the fusing constants for all the metals in general use when bare and exposed in still air. The numbers indicate the current in amperes which is required to fuse a cylindrical conductor of a diameter of 1 cm. of the material named.

	Fusing constant. (*a*).	Fusing temperature. C°.
Copper	2530	1054
Silver†	1900	954
Aluminium	1873	650
German silver	1292	1200
Platinum	1277	1775
Platinoid	1173	1300
Iron	777·4	1600
Tin	405·5	226
Lead	340·6	335
Alloy (lead 2 parts, tin 1 part)	325·5	180

I have added the temperature of fusion to each of these metals, and the table means that if we take, for example, a uniform copper wire of 1 cm. diameter, a current of 2,350 amperes will raise it to 1,054deg. C., and therefore fuse it; and if we take any similar conductor of copper, but of different diameter, d, the fusing current, C, is

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* This is the fourth paper on the subject of "Heating Effects" that Mr. Preece has contributed to the *Proceedings* of the Royal Society.

† G. Roux, *L'Electricien*, December 14, 1889.

$$C = 2{,}530 d^{\frac{3}{2}}.$$

The fusing current of any other material is obtained from the equation

$$C = a d^{\frac{3}{2}}.$$

It seemed natural that these constants, marking such a distinct and well-defined fiducial point, should also enable us to obtain the currents that would raise the wire to any other temperature.

A constant current traversing a cylindrical metallic conductor does work, W, upon that conductor to an amount which is measured per second by the product of the E.M.F., E, at the ends of the conductor, and the current, C, or

$$W = E\,C.$$

This work appears as heat. The temperature of the conductor is raised. When the temperature of the wire becomes constant the expenditure of energy in the wire, and its dissipation by radiation and convection from the surface of the wire, must be equal and constant also. Hence the temperature of the conductor when constant becomes a measure of the work done per second, and therefore a measure of the constant current flowing. The rate of loss of heat per degree per unit area of any surface is its emissivity, e. The value of e depends upon the character of the surface—that is, whether it is polished or rough, clean or dirty, bright or black, metallic or oxidised, painted or coated with some preservative or insulating medium. For the present we will consider an unprotected surface, comparable with the surface when at white heat, and we will call that surface *normal*. Let a current be applied to a given conductor, exposed in still air at atmospheric pressure, until it assumes any constant temperature, T, the surrounding objects being at a lower temperature, T_1; then the total heat, W, which will be emitted per second by the whole surface, S, of the wire to the surrounding objects will be

$$W = e\,S\,(T - T_1).$$

Hence
$$E\,C = e\,S\,(T - T_1)\,. \quad . \quad . \quad . \quad . \quad (1),$$

or
$$e = \frac{E\,C}{S\,\theta},$$

if we put θ for $T - T_1$, the excess of temperature acquired by the wire.

Hence we can determine e for any conductor at any temperature by measuring E C and θ.

Putting $E = C\,R$, $S = l\,\pi\,d$, and $R = 4\,\rho\,l\,/\,\pi\,d^2$ (ρ being the specific resistance in C.G.S. units, l the length, and d the diameter in centimetres), (1) becomes

$$4\,C^2\,\rho = e\,\pi^2\,d^3\,\theta,$$

and
$$\theta = \frac{4\,C^2\,\rho}{e\,\pi^2\,d^3} \quad . \quad . \quad . \quad . \quad (2).$$

Now, if ρ and e vary together in the same proportion in terms of θ, then $\theta = \kappa\,C^2$ for any particular wire. That ρ and e do vary together in the same proportion is entirely in accordance with measurement and experiment; and it is interesting to note that it is also in accordance with the researches of Mr. J. T. Bottomley on thermo-radiation (Phil. *Trans.*, vol. 178 (1887), A, pp. 429-450). Thus, if we take the table given on p. 443 of that paper, and work out the variation in resistance of a platinum wire (which variation is the same as for copper) by the usual formula,

$$R_t = R_0\,(1{\cdot}0038)\,\theta,$$

we get the values shown in the fourth column:

Bottomley's Researches			R_t calculated from the formula $R_t = 14{\cdot}5\,(1{\cdot}0038)^{\theta}$.
θ	$C^2/R\,J\,s.$	$e.$	
65°	$9{\cdot}45 \times 10^{-4}$	$14{\cdot}5 \times 10^{-6}$	14·5
110	20·53 ,,	18·7 ,,	17·2
232	74·7 ,,	32·2 ,,	27·3
383	236 ,,	61·6 ,,	48·4
740	1468 ,,	198 ,,	187·6
900	3218 ,,	358 ,,	344·2

If we determine C for any temperature, then, since $\theta = \kappa\,C^2$, the current C′ producing any other temperature θ' is obtained by means of the equation

$$C' = C\sqrt{\frac{\theta'}{\theta}}.$$

Now, for copper of 1 cm. diameter C = 2,530 for 1,054deg. Thus, if we want to find the current that will raise such a conductor to 13deg., we have

$$C' = 2530\sqrt{\frac{13}{1054}} = 281 \text{ amperes},$$

if the surface be equivalent to the assumed normal surface

Now, since we are dealing with metallic surfaces only, and the normal surface has been defined to be that comparable with the surface when at a white heat, it remains for us to determine the coefficient which shall convert this normal surface emissivity to that of the surface of ordinary wires at low temperatures. This I have done for copper, and the results have been amply confirmed by Mr. Kennelly, in Mr. Edison's laboratory at Orange, N.J., U.S.A.*

Taking the normal surface as unity, then

	Surface coefficient.
Bright and polished copper	0·5
Copper, dirty, oxidised, or blacked with shellac varnish	0·6
Copper, well coated with lampblack	1·0

Taking a wire 1 cm. in diameter and calculating from $C' = 0{\cdot}5\,C\sqrt{\frac{\theta'}{\theta}}$ for bright wire, and $0{\cdot}6\,C\sqrt{\frac{\theta}{\theta}}$ for black wire, we get

5deg.				10deg.				20deg.				40deg.				80d .			
Bright		Black		Bright		Black		Bright		Black		Bright		Black		Bright		Black	
P	K	P	K	P	K	P	K	P	K	P	K	P	K	P	K	P	K	P	K
87	85	104	104	123·2	120	148	147	168	169	201	207	243	236	291	290	350	329	420	410

N.B.—P means calculated from the formula $C' = 1265\sqrt{\frac{\theta'}{\theta}}$, and K means the figures obtained by Mr. Kennelly.

a concordance which is very satisfactory.

Now the current, C, producing 1,054deg., θ, in a bare bright copper cylinder of 1 cm. diameter is $0{\cdot}5 \times 2{,}530$ amperes, and that which would produce a temperature of 10deg. C. is

$$0{\cdot}5 \times 2{,}530\sqrt{\frac{10}{1{,}054}} = 123{\cdot}2 \text{ amperes}.$$

Using both alternating and continuous currents, it was found that in a copper wire with $d = 0{\cdot}6956$, θ was 50·3deg. Now the current, C′, that will raise a wire 1 cm. in diameter 50·3deg. in temperature is

$$C' = 2{,}530\sqrt{\frac{50{\cdot}3}{1{,}054}} = 552{\cdot}7 \text{ amperes}.$$

But the current that will raise a wire of a diameter of 0·6956 cm. through the same temperature is

$$(C \times d^{\frac{3}{2}}) = 552{\cdot}7 \times {\cdot}6956^{\frac{3}{2}} = 320{\cdot}6 \text{ amperes};$$

or, if the wire be dirty,

$$320{\cdot}6 \times {\cdot}6 = 192{\cdot}4 \text{ amperes}.$$

The current actually was in each case 198 amperes.

Time.	Increase of temperature of wire. C.	Current in amperes.	
		Observed.	Calculated. $C' = 0{\cdot}6\,C\sqrt{\frac{\theta'}{\theta}}\Big/ d^{\frac{3}{2}}$.
10.45		454	
11.15	86°	454	467·7
12.0	80	450	451
3.30	79	445	448
3.45	78	440	445
4.30	73	429	431
Current stopped; wire cooled. Current put on again at 5.30.			
6.0	38	29	310

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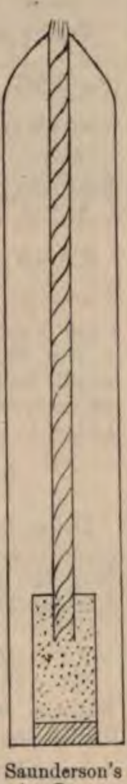
* A. E. Kennelly, "On the Heating of Conductors by Electric Currents" (abstract of report read before the Edison Convention at Niagara Falls, August, 1889; *Electrical World*, November November 30th, December 7th, and December 14th, 188

A copper conductor, bare and dirty, 20ft. long and 0·415in. in diameter, was stretched across a room where the air was still, and various continuous currents were transmitted through it. The results are tabulated, and the observed and calculated currents given in the preceding table.

Thus, if we know the current producing any fixed temperature in any cylindrical conductor, we can readily calculate the current required for any other temperature.

SAUNDERSON'S IMPROVED ARC LIGHT.



Saunderson's Arc Lamp.

For many years there have been efforts made for the improvement of carbons for electric arc lamps with some measure of success, also for introducing various materials into the arc, but in no case has any important advantage been gained. In many cases certain substances have been ground up and incorporated with the carbon, with the result that ashes or clinkers have been formed to such an extent as to render the light of less rather than greater intensity. The most successful carbons have been those made up with finely powdered soft carbon dust. A very remarkable discovery has been made which will certainly give an enormous impetus to electric lighting. The inventor, Mr. Llewellyn Saunderson, of Kingstown, county Dublin, whilst experimenting with the arc lamp in his endeavours to improve its powers to pierce fog, so as to minimise loss of life at sea, determined upon introducing into the arc minute quantities of intensely heated hydrocarbon vapour so as to enrich the light with the well-known fog-piercing rays—viz., yellow and red. Having succeeded by this means in producing a beautiful sunshine yellow, he discovered that at the same time the intensity of the light was enormously increased. A plant was put down consisting of gas-engine, dynamo, and electric arc lamps, and the question was followed up by introducing various gases into the arc in a number of curious ways, only a few of which can now be described. The first consisted of a jet through which the vapour was projected into the arc, then two jets, and so with a number of other contrivances. The hydrocarbon was vapourised in the tube leading to the jet, and retarded in its passage by asbestos, etc., to give the carbon time to bring the vapour up to an intense heat, and a wick was employed to prevent the vapour from going back, as well as to supply fresh fluid by capillary action. Having thoroughly convinced himself that a substantial improvement of the light could be produced without requiring additional power from his gas-engine and dynamo, the inventor now contemplated bringing his new light forward for actual tests against the best light that could be produced by the carbons now universally employed in arc lighting. He made enquiries as to who he should ask to assist him, and Lord Crawford very kindly allowed some temporary tests to be made at the store of the London Electric Supply Corporation in the Adelphi-terrace, but the exigencies of the business of the corporation were such that the long and laborious investigations required could not be continued. Subsequently the inventor was recommended to apply to Mr. Apps, 433, Strand, London, so well known for his work in connection with physical science, and after careful consultation it was decided to put down a plant consisting of gas-engine, dynamo, storage cells, and two large Brockie-Pell arc lamps, each taking about 45 volts and 12 amperes. This plant began running in May last year, and was designed and fitted up by Mr. Apps with a full complement of testing instruments of the most approved design. The two lamps were arranged at the ends of a long photometer scale, the photometer being in the centre, and the lamps vertically placed at each end. The exact candle-power of either lamp was not thought to be important, but the precise relation of the lights of the two lamps was the point to be ascertained, the energy to each being indicated by the sets of instruments placed on the walls opposite. At this stage the experiments were greatly extended, and many thousand observations taken, with a general mean result agreeing with that separately and afterwards determined by Dr. Hopkinson. It was found, however, that for very exact measurements greater steadiness was absolutely necessary. Having now procured readings of a reliable nature, and of the most extraordinary character, the inventor was advised to call in Dr. John Hopkinson, M.A., D.Sc., F.R.S., etc., to report to him on the power of the new light as compared with the old arc light. A pair of black velvet screens were ordered to be placed behind the lamps, and the whole of the framework also was coloured a dull black. The tubes of the photometers were also lined with black velvet, and special arrangements were contrived to get the maximum steadiness of light from the lamps. At this point some measurements were taken which were fully verified subsequently, but the unsteadiness of the light was still a serious source of difficulty. The lamps were now made to rotate in their own frames, and to be inclinable at any angle also, the automatic regulating mechanism being entirely removed, and a screw arrangement added for hand regulation. By this means the possible errors due to craters were almost entirely eliminated, and after taking a great number of readings Dr. Hopkinson decided to make his report, which is as follows :

The Report of Dr. John Hopkinson, M.A., D.Sc., F.R.S., &c.

Arc Lamp with Hydrocarbon.

The peculiar feature of this invention is that the lower or negative carbon is hollow, and is connected with a reservoir of hydrocarbon, as tried by me, Young's paraffin, density 0·865. This oil passes up the hollow carbon into the arc.

The object of my experiments was to ascertain what advantage, if any, resulted from the presence of the hydrocarbon. Two arc lamps were provided, identical in all respects, with the exception that to one of them the invention was applied. The E.M.F. and current supplied to each arc were measured by voltmeters and ampere-meters, which were afterwards compared with each other, and were found to give the same indications for the same currents. The lights given by the two arcs were compared by a photometer generally of the ordinary construction. In a part of the experiments the ordinary Bunsen grease spot was replaced by the so-called Joel's photometer, consisting of two pieces of obscured glass, the results with the two instruments are in fair accord.

In order to diminish the very considerable variation dependent upon the position of the crater, the lamps were inclined so that the axes of the carbons made an angle of 45deg. with the horizontal, the craters in the two upper carbons facing each other. Between successive observations the lamps were turned through an angle of 180deg. about the axes of the carbons, so as to reverse the favourable or unfavourable position of the craters. As might be expected, the observations varied very considerably, and the mean of the observations only is given here. In obtaining this mean the whole of the observations are included with the exception of six—three extremely favourable to the new lamp ; three, on the other hand, unfavourable.

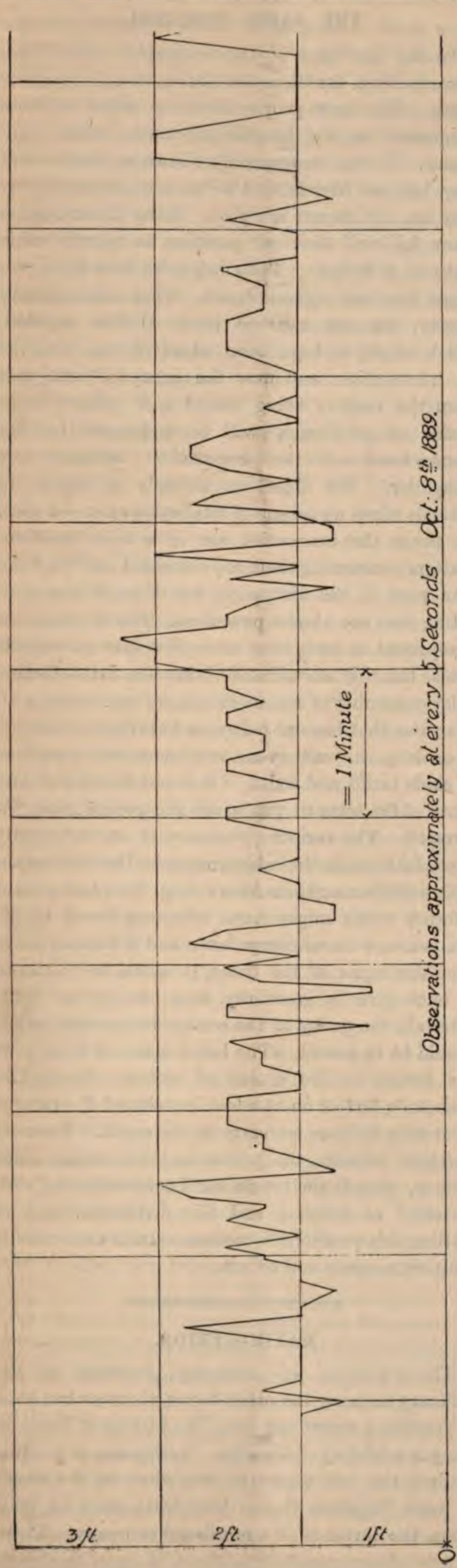
The final result which I find is this : Mean potential of ordinary lamp, 39·8 volts ; of new lamp, 41·4 volts ; mean current of ordinary lamp, 12·4 amperes ; mean current of new lamps, 11·1 amperes ; mean energy in ordinary lamp, 493·5 watts ; mean energy of new lamp, 459·5 watts ; mean ratio of the light given by the new lamp to the light given by the old lamp, 1·88. Thus, in these experiments, whilst consuming somewhat less energy, the new lamp gave nearly double as much light as the old lamp. There is, therefore, in an arc of this size a substantial advantage from the use of the invention.

J. Hopkinson.

5, Victoria-street, January 31, 1890.

Among the great advantages of this discovery we may mention increased steadiness, and, instead of the bluish tint always present in the ordinary arc, a fine rich, yellowish-white colour, very agreeable to the human eye, is produced, being almost exactly the same as sunlight, and having, it is said, an enormously increased power of penetrating fog, so important for lighthouse purposes, and for use in the military and naval electric light projectors.

The item of expense in applying the new system is so small that it may be neglected altogether, and very little or no alteration of the present arc lamps is required. The simplicity and cheapness of manufacture is, in fact, so great that it is probable not more than 20 per cent. or 30 per cent. in total cost need be added to the present cost of the carbons against the diminution of the general cost. It may well be asked how these results are attained. Up to this moment there is, perhaps, no sufficient explanation,



Photometric Curve of the Saunderson Arc Lamp.

but it is highly probable that the exceedingly fine particles introduced into the arc, and impinging against the upper carbon by the ascent of the hydrocarbon vapour, are acted upon with great advantage by the electrical energy, whereas the harder particles of the carbons have to be taken from their state of cohesion, greatly reduced in size, and even then only a small percentage are found suitable for the higher incandescence (from which most of the light is derived), the grosser particles falling in dust, found after the lamp has gone out; while portions more refractory are discharged at all angles, and sometimes with considerable force. For instance, such particles have been found embedded in the surface of massive glass lenses placed some four or five inches distant from the arc flame in a horizontal direction. The work done in heating a refractory and unsuitable body for the production of light must evidently be attended by considerable loss of energy. On the other hand, the hydrocarbon vapour is (by means of the waste heat of the carbon, at a point not far from its lower end) obtained from the absorbent wick, from which it ascends, being lighter than the surrounding air, and after being raised to an intense heat as it passes upwards, and having enormously expanded, it passes into the arc. The quantity of vapour required is astonishingly small, that which can be produced from a drop of oil lasting, with ordinary carbons, nearly a minute. It is, however, not necessary to employ oil, but almost any substance or semi-liquid which on being heated gives off the vapour will answer well. For example, vaseline enclosed in a small capsule of the same size as the rod of carbon, and not more than about ½in. long, will hold sufficient for the burning of the carbon down to the usual length at which it is generally taken out and thrown away. It is probable that the minute quantity of vapour required is acted upon freely, and that in its turn the incandescent gas or particles of vapour assist largely in effecting the separation of the particles of the carbon electrodes, for the consumption of carbon is increased by about ⅐th part. The light is said to be far more agreeable to the eye, and of much greater steadiness, while as to economy, arc lighting with this improvement, it is contended, is equal to gas at about 3d. per 1,000 cubic feet. With reference to search-lights, it is evident that by adopting the invention the illuminating power, and generally the actual value of these appliances, will be doubled, which may be an important factor in some not very distant naval action.

We have visited the laboratory of Mr. Apps where the experiments were carried out, and Mr. Apps has furnished us with a photometric curve taken before the date of Dr. Hopkinson's report, which bears out the result given. The observers sat with one hand on the hand regulating screw, watching to keep the voltmeter and ampere-meter steady, while the photometer was shifted till the lights balanced. The lamp was rotated at each test, and readings were taken every five seconds. The diagram shows these readings in a graphic form. It will be seen that the average distance of the photometer is some 2½ft. from the zero line away from the vaselined carbon, which, calculating by the law of squared distances, shows the new carbons yield double the light for the same current. The carbons are now being made with a brass ring round the base, forming a small compartment for the hydrocarbon, from which the asbestos wick rises through a small hole along the length of the carbon. It is the frittering away of the asbestos wick that prevents clogging from the deposition of hydrocarbon, as in the process of "flashing." The cost of the new carbons is given at about 6 per cent. only above ordinary carbons.

This invention is now being tried in a large installation in England. The results have been found to be practically the same as those certified by Dr. Hopkinson.

A Model for England.—The New York Electric Club is a model organisation of its kind and its *cuisine* ranks with that of the best hostelries in the metropolis. It is quite remarkable, too, what a headquarters and rendezvous it has become for electrical men and their friends.—N.Y. *Electrical Review.*

THE

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Specimen copies of the paper will be sent on request.

THE PARIS CONGRESS.

To-day the eyes of the telegraphic world turn towards Paris, for there the International Congress meets. The only people likely to suffer at these congresses are the English submarine cable companies. It was conclusively shown at Berlin that they had no friends, and we most emphatically say they are not shown fair play. Many of our readers know full well that our position, as regards cable matters, is unique. The companies have their own organ, but that organ is dumb. They subsidise very largely, but can call no tune. Public opinion, which ought to have been educated, has received no information, and now the agony of being put upon the rack, of being kicked and cuffed without means of retaliation will be undergone by the management of the companies without any sympathy. We object as strongly as anyone to criticise when no means of retaliation exists—hence, we think the companies are in a false position. Matters concerning them are discussed and they can take part in the discussion, but when it comes to voting they are almost powerless. The Government is supposed to look after their interests as regards votes, but this secondhand voting has little efficacy. A large number of the members are connected with countries that have no cables, and are little interested in cable work, yet they can vote upon such questions as cable tariffs and codes. It is not fair play in any sense of the term to put aside the people most interested. The various governments are sufficiently powerful to make the cable companies listen to reason without debarring them from voting. There are certain reforms which might have been introduced by the companies without compulsion, and if we may judge from the signs of the times, it would be better to at once give in gracefully than attempt to fight. After all, the policy of the companies and the public should be in accord. The latter is bound to support the former to the extent of success. Companies cannot be carried on at a loss, nor should the returns from such delicate property be too small. The only question between the public and the management then is, what is the lowest tariff commensurate with certainty of working and fair dividends; and in settling this question the management is undoubtedly entitled to speak and to vote.

MAXIM-WESTON.

The report of this company presented at the ordinary meeting the other day is about as bad as it is possible a report can be. The history of the company is a history of a failure. Litigation is pending against the late chairman, but whatever the result of such litigation it can have little effect for good upon the fortunes of a moribund company. There is one phase especially of the history of this company which should never be forgotten. It is not for us to discuss the reasons, but as fairly as possible to state the facts. In the early days of the company, Mr. Maxim was brought over from America under a somewhat stringent agreement. Among other things specified in this agreement, we believe, was a stipulation to the effect that Mr. Maxim was not to enter into any electrical researches outside his work for the company. He came to England; he attempted to work for the company, but, to say the least, was thwarted and prevented from working. Unable to go on working at electrical subjects, Mr. Maxim, as is well known, took up the question of automatically firing guns, and with what success is known to all the world. The Maxim-Weston Company had, according to agreement, the command of the services of one of the most talented mechanicians of the age, and which we honestly believe if they could have been, as they would have been—indeed, as Mr. Maxim wanted them to be—exerted in the services of the company, that company to-day, instead of being in the position it is, would have stood in the front of successful companies. The report deplores that the company has had to be worked by men who know nothing technically of electricity in competition with companies managed by men who have both the genius for business and the technical knowledge necessary to prevent their rushing into error. If what we have said about the transaction with Mr. Maxim is correct, whose fault is it that the company is in the position it now occupies? Our information is to the effect that the position is due simply and solely to the action of the late chairman, Mr. Hugh Watt. While deploring the condition of the company, it ill becomes the present directors to try and cast a glamour over the shareholders by still further showing their entire ignorance of the position of other electrical companies. The chairman at the meeting combated the statement of the *Financial News*, that "in these days electric lighting companies were fairly established and were paying dividends," and then, in reply to a shareholder, made certain remarks about Messrs. Woodhouse and Rawson which are unwarranted by facts. We shall be somewhat surprised if the company referred to does not take an early opportunity of replying to the statements. We have pointed out an error made under previous management, but errors did not end with that management. The balance-sheet as presented shows patents value, so much. Now is it a fact or is it a fiction that many, if not all, the patents have been allowed to lapse by non-payment of the dues thereon? If no patents exist, how can they be of value? This is a question concerning the present management. Do they think it possible, if the patents are worth working, that competitors will not adopt what is now free to all the world? A patent is worth something when it is practical and a monopoly; or a business is worth something that has been built up during the time a patent has been running. Those who have any interest at all in the matter will agree with the chairman, that whatever the company has touched has turned to ashes. A splendid example of how not to do it; a more splendid example of idiotic company-mongers getting rid of able, competent men, cannot be found in the whole history of limited liability, and yet such is the law that it is doubtful if anyone can be blamed.

CORRESPONDENCE.

THE LANE FOX PATENTS.

To the Editor of The Electrical Engineer.

Sir,—With reference to the article in your issue of the 9th inst., regarding the Lane Fox patents, will you allow me to point out that you appear to be under a misapprehension as to Mr. Lane Fox having claimed to be the discoverer of earth returns. As you point out, in 1878 this would have been a "monstrous claim."

"The galaxy of talent" to which you refer does not, as seems to be suggested in your article, maintain that such a claim was a valid one; for, as a matter of fact, Mr. Lane Fox has made no such claim, either alone or in combination. All that the experts point out in this connection is that the use of the word "earth" in the specification is merely descriptive; and that it properly and sufficiently indicates any return path for the electric current.

The system of incandescent lighting claimed is described by Sir William Thomson as one for "distribution in parallel arc, in conjunction with secondary batteries as reservoirs of electricity."—Yours, etc.,

C. A. Stephenson,
Managing Director Lane Fox Electrical Company,
London, S.W., May 13, 1890.

WYNNE'S URBAN ELECTRICAL TRAMWAYS.

To the Editor of The Electrical Engineer.

Sir,—In your notice of this, quoting my references to the accumulator system at Brussels, and its failure there, you say, "This statement, though true in fact, takes into no consideration concomitant circumstances, to which we have already alluded, prominent amongst which were certain municipal difficulties," etc. My information was direct from Brussels, but before replying to the above I wrote for further information, putting your points, and this is the reply: "The surrender of the Julien system is due principally to the economic cause and to the cost of maintenance of the accumulators. No difficulty with the municipality."

You traverse my statement that "no material advance whatever has been made in accumulators" for traction purposes during the last eight years, but will you kindly specify the material improvements which have been made. I supposed myself fairly well conversant with what has been done with accumulators, and I certainly ought to know of any material improvement, but if you can prove me wrong you may do so, and I will readily admit my unintentional error. What I do know is that for the last eight years "projects have been in hand," long and steep lines "will shortly" be economically worked, accumulators are "going to be" improved. Meanwhile, the overhead system carries all before it.

You say that I cavalierly dismiss the insulation of the sectional conductors "with ordinary grouting." This is not quite what I did say; I said that the sections and the setts should be "well laid in ordinary *pitch* grouting," which is the grouting used in Manchester, Liverpool, and Glasgow, and is a very different thing from ordinary grouting—besides, I point to the short length of the charged section. As to the main conductor of electricity being inaccessible, it is precisely as accessible as any other main conductor of electricity which is laid in the road.—Yours, etc., **Frank Wynne.**

ELECTRIC TRAMWAY SYSTEMS.

To the Editor of the Electrical Engineer.

Sir,—In your issue of last week you publish a description of an electric tramway system, called the Waller-Manville, for which several features are claimed as new. I beg to point out to you that this system is by no means new, having been patented by me in 1887. In my specification (Improvements in Electrical Tramways and Railways, No. 14,029, October, 1887), a copy of which I enclose, will be found a full description of this method of insulating and collecting from a flexible cable.

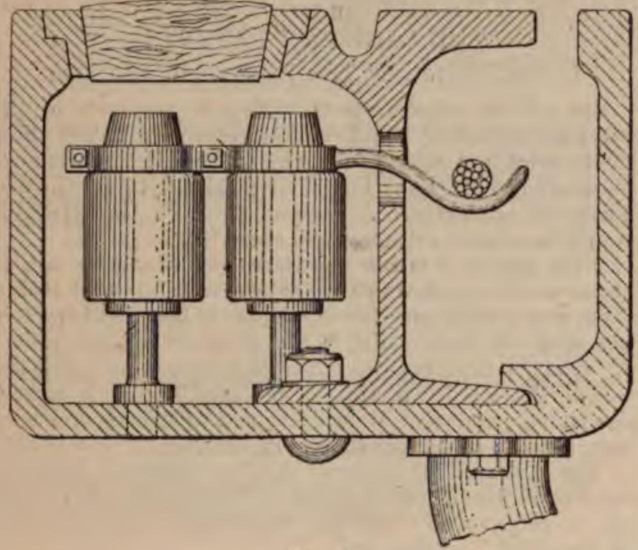

Fig. 1.

To Mr. Volk, of the Brighton Electric Railway, is due the credit of having first employed insulators of the telegraphic form for an electric tramway system (*see* specification No. 9,388, August, 1885), and also of providing removable lids allowing access at all times to them. Mr. Volk, however, *fixed* his conductor to the insulators, and it was to get over the difficulty, caused by the breaking of the insulators, that I designed the system with a flexible cable *resting* on hooks supported by insulators, as shown in my specification and your description of the Waller-Manville system. This method of insulating and collecting from the conductor is the very essence of my system, and it will be seen on comparing my specification with your description that the method employed in the Waller-Manville is identical.

The claims made of the conductor being removable through the slot, accessibility of the insulators, collecting arm rigidly fixed to the car, etc., are all mentioned in my specification, and it is difficult to see any new points in the Waller-Manville system, except a slight alteration in the form of the conduit, and one or two mere matters of detail of which any mechanic could sit down and work out innumerable shapes.—Yours, etc., **F. C. Allsop.**

165, Queen Victoria-street, E.C., May 12th, 1890.

[We reproduce Fig. 1 from the specification sent by Mr. Allsop.—Ed. *E. E.*]

ELECTRIC TRAMWAY DATA.

BY CARY T. HUTCHINSON, PH.D.

(Concluded from page 352.)

Same measurements of the time required to stop and start the cars taken here, of which the results are given below; the timing was done by a man on the car with a stop-watch.

The motor car weighed 10,000lb.; the tow car, 5,300lb.

FOR MOTOR CAR:

A. Time car remained stationary.

Average of 77 readings.................. 7·1 secs.
Maximum .... 22 ,,
Minimum .... 3 ,,

The readings are all close to the mean; the 22 is unique, and no other is near it.

B. Time for starting car to two poles' distance—that is, 250ft.

Average of 128 readings .... 22 secs.
Maximum .... 30 ,,
Minimum .... 12 ,,

All very close to the mean.

C. The time for throwing off current to stop:

Average of 95 readings.................. 12·8 secs.
Maximum .... 21· ,,
Minimum .... 5· ,,

All very close to the mean; the distances varied from 100ft. to 120ft.

D. Time of running from pole to pole—that is, 125.ft; full speed.

Average of 208 readings, 6·25 secs.—13·7 miles per hour.
Maximum .... 7 ,, 12·2 ,, ,,
Minimum .... 5 ,, 17· ,, ,,

Same for motor with tow.

A. Average of 145 readings .... 8·25 secs.
Maximum .... 45· ,,
Minimum .... 2· ,,

No readings between 20 and 45 seconds; the readings are fairly close to the mean.

B. Average of 132 readings............... 23½ secs.
Maximum .... 30 ,,
Minimum .... 18 ,,

All close to the mean.

C. Average of 111 readings............... 11·5 secs.
Maximum .... 23· ,,
Minimum .... 7· ,,

All close to the mean; average distance 150ft. to 190ft.

D. Not taken.

The following tables give most of the above results and some deductions from them:

Table I.

—	1	2	3	4	5	6	7	8	9	10	11
Roads.	Average number of cars running.	Car mileage.	Mean i.h.p. in station, per car.	Mean i.h.p. per car on the line.	Mean e.h.p. in station, per car.	E.H.P. on car, no tow.	E.H.P. on car, with tow.	Ratio of power; motor car + tow to motor car.	Mean starting current in amperes.	H.P. hours per car mile.	Insulation in meghom-miles.
A.	8·24	107	8·1	5·4	6·7				82	·96	·15
B.	23·4	103				6·2	8·5	1·38	80	·84	6·9
C.	9	105				7·7			47	1·15	3·2
D.	14	105	6·2	5·2		8·6			75	1·44	·4
E.	8	110	8·3	5·3	6·5	8·1	10·3	1·27	80	1·05	·5
Ave.		106	7·5	5·3	6·6	7·6	9·4	1·33	72	1·09	2·2

Table II.

Power on grades—average:

A. 4 per cent.	17·9 h.p.
A. 6 ,,	22·1 ,,
C. 1·43 ,,	11·9 ,,
C. 3·25 ,,	15 ,,
C. 3·8 ,,	18·5 ,,
D. 9·5 ,,	24·7 ,,

Table III.

Cost:

Average of all the four roads in per cent.:

Carmen	69·5
Maintenance	11·5
Generating power	19
	100·0

Of the power-house :

Labour	11·0
Fuel	6·3
Oil, waste, etc	1·7
	19·0

Column No. 4 in Table I. is the first that calls for comment. These figures are obtained from deducting the friction card from the mean i.h.p. and dividing by the number of cars. The result is roughly constant, which, of course, means nothing more than that the power on the car is nearly constant in spite of the varied conditions of the road, and should show in the electrical measurements as well as in the i.h.p. ; for "D" and "E" the car measurements are nearly the same—viz., 8·1 and 8·6 h.p. On the other hand, taking the average power from station readings, "A" and "E" agree—viz., 6·7 and 6·5 h.p.; so the values tie up, so to speak. The electrical readings do not, however, agree as closely as the mechanical.

The car readings were all taken at 30-second intervals ; it was thought that this would be clear enough to give a good average, but it is not. I believe that no readings taken at equal intervals—that is, such intervals as are practicable—will give a fair average in all cases. The only right way is to have a recording meter, a wattmeter, if possible, or otherwise an ammeter, which will give a continuous record. Next to this the best plan is to take readings at every change of the current, the time being noted ; then plot the readings and integrate the curve. With 30-second readings I have got smaller power in cases when it obviously should be greater.

The chief reason for the discrepancy between car and station readings is probably the much too great frequency with which the high readings are caught ; it takes the current from three to five seconds to fall from the maximum to its normal value ; yet almost every high reading seems to be caught. Further, no readings are taken when car is standing at its termini. Besides, the station ammeters have heavy moving parts, and hence do not respond to sudden changes.

Column 10, giving the horse-power hours per car mile, is calculated from the average of the station readings in the case of "A" and "E," together with the average car mileage and average time of running. But in the case where no station readings were taken, the actual time of a round trip is taken ; for "D," however, the car value had to be used with the average mileage, on account of the numerous delays on the run ; this case shows the greatest divergence from the mean.

The mean starting current is low for "C," because there the old style Sprague motors are used, which have about double the resistance of the present style. It will be noticed that these figures for starting current are much higher than those given in Mr. O. T. Crosby's recent paper, the reason being that he used an Ayrton and Perry spring ammeter. This instrument is not dead beat, and the first reading taken is far from the greatest actually attained.

The insulation is abundantly high in all cases, remembering the low-line resistance. Besides, only 30 volts was used in measuring it, while 500 is the ordinary E.M.F. There seems to be no special difficulty in keeping the insulation high enough for this kind of work ; ·01 megohm-mile would be ample for a minimum figure.

The power for grades does not vary just as one might expect. For instance, for the 3·8 per cent. grade greater power is taken than for the 4 per cent., but it must be remembered that these are far different roads with entirely different conditions of track.

The ratios of the various items in the cost of a road are rather instructive. The figure given for maintenance is, I believe, nearly correct as an average. The value for "A" is abnormally low, while for "B" it is equally high. The small part of the cost chargeable to fuel is noteworthy ; doubling the number of cars on the line would involve in an ordinary station very little increase in cost of generating power ; labour probably being not at all, and oil, etc., only slightly increased.

In conclusion, I may say that the roads here reported on are not selected as the best by any means, but were chosen simply as falling into a convenient arrangement of routes ; one in particular is an old road, with all old-style motors.—*Electrical Engineer* (New York).

LIGHTNING-GUARDS FOR TELEGRAPHIC PURPOSES.*

BY DR. OLIVER LODGE, F.R.S., MEMBER.

In the paper which I read before the Institution last year, I spoke at length and showed some experiments on the subject of the protection of buildings from lightning ; but although there were a few sections in that paper, as ultimately printed, dealing with lightning-protectors for telegraphic instruments and cables, yet time prevented my calling attention to this portion of the subject at the meeting, or of showing any experiments in connection with it.

The present communication may be regarded as a development of this omitted but important branch of the subject.

I do not know whether I shall escape controversy this time, but I have no wish to provoke it, and I wish entirely to avoid decrying the merits of other specific protectors in order to emphasise the advantages of my own. All I have to say on this head will have a quite general application, and amounts to about this : that whereas all protectors proceed on the admitted fact that the greater portion of a sudden flash prefers to jump an air space, rather than traverse a moderate length of wire, the cause of this well-known fact was but imperfectly appreciated ; could not, indeed, be perfectly appreciated without recognising the rapid oscillatory character of sudden discharges, and the doctrine of impedance or immense obstruction which good conducting wires offer to currents of this character : an impedance, it may be, of 100 or 1,000 ohms, whereas the resistance to steady currents may be but a ten-thousandth part of this amount.

In a word, the complete theory of lightning-protectors has not till recently been known; and, accordingly, the many ingenious devices which are in use are naturally deficient in details which a completer recognition of theory would have suggested.

Long ago it was shown, by the experiments of M. Guillemin and Prof. Hughes, that existing lightning-protectors were not perfect safeguards, inasmuch as they could not protect a fine wire from deflagration by a Leyden jar discharge. At the same time it was admitted by these experimenters, and is, I understand, a matter of common experience, that almost any lightning-protector is better than none at all, and that the best of those in use are by no means inefficient instruments. They do not afford perfect security, but the occasions when they partially fail are perhaps not very numerous. It is therefore the practice to establish some sort of proportion between the elaborateness of the protector and the value of the apparatus to be guarded. In telephone exchanges a simple double comb is used. In telegraph offices a pair of plates finely adjusted close together is the form employed, while at cable stations the most elaborate kind of protectors, and often a number of different ones in combination, are arranged, because of the enormous interests at stake.

In electric light installations, on the other hand, it is customary, I believe, at present to use no protector at all. But I cannot suppose that this will much longer be regarded as a reasonable procedure. When one considers the extensive ramifications of conducting leads which are rapidly growing up. and the liability of the neighbourhood of house lightning-conductors to some portion of such ramification, it is apparent, I think, that lightning arresters are just as important for electric light leads as for telegraph wires. However, there is no need for me to emphasise this assertion, for I expect that before long a flash from somebody's lightning-conductor getting into some electric light leads and burrowing underground throughout a district will do an amount of damage sufficient to eloquently call attention to the danger. At Peterhouse, Cambridge, lightning got at the gas-engine, thence to the dynamo, and thence into the leads, where, I believe, it did little more than fuse a large number of cut-outs. But it is not likely always to spare the lamps in so considerate a manner; while danger of an altogether more disastrous kind can by no means be considered absent.

Returning from this digression to the telegraphic protectors at present in use, my contention is that in all except the very simplest and crudest form of protector, a perception of the true conditions may lead to more complete protection without necessarily much increase in cost. And proceeding to cases where cost is altogether a secondary consideration, and supposing it possible that telegraph engineers are fairly satisfied with the quality of the protection at present supplied to submarine cables, I would ask them (not pretending to know anything at first hand about the matter) whether a number of obscure and unexplained faults do not develop themselves in the guttapercha of cables; whether it is not possible that some of these are due to electric waves of high potential which have got into the core and punctured its dielectric at previously weak spots; whether, indeed, such faults are not found occasionally to develop in the wake of a storm?

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* "On Lightning-Guards for Telegraphic Purposes, and on Protection of Cables from Lightning, with Observations on of Conducting Enclosures." Paper read before the Electrical Engineers, April 24th, 1890.

I would also point out that the fact that a lightning switch is found damaged, or its wire, perhaps, fused by a flash, is no proof that it has entirely protected the cable from hostile influence. It shows that it has done the best it can; but since that best falls short of perfection the damage to the protector, proving that there has been occasion for its activity, proves likewise that the cable has been in a position of danger, has received some proportion of the damaging current, and in all probability has suffered some amount of deterioration. The voltage which plays about in the very feeblest form of statical discharge is so enormously greater than anything ever developed by ordinary voltaic batteries that one cannot regard with equanimity the entrance of any portion of such E.M.F.'s into the delicate vitals of a cable. Remember that a millimetre spark means 3,000 volts.

To illustrate by experiment the assertion I have virtually made—that no conceivable form of single air gap, whether it be between knobs, or points, or plates, or wires, or between wire and tube, or coil and cylinder, or any other possible device, can possibly afford complete and adequate protection—I take the following simple instances:

Experiment No. 1.

Arrange a small air gap, as, for instance, between the knobs of a common "universal discharger"; connect the ends of a tangle or loop of thin covered wire, one on each side of the gap, and pass a Leyden jar discharge across it. The insulation of the thin wire is sparked through wherever two portions happen to come close enough together. [The wire actually employed had been the secondary of an old induction coil, and had been well soaked in paraffin.]

Experiment No. 2.

Diminish the air gap until the knobs actually touch. The sparking at the crossings of the tangle are rather less bright and numerous than before, but they still frequently occur.

Experiment No. 3.

Instead of an air gap, however short, use a foot or two of stout No. 0 copper wire or rod of highest conductivity, and shunt this with a thin wire tangle or coil. On passing a discharge along the rod, the crossings of the tangle sparkle as before, showing that the double insulation is still broken down.

These extremely simple observations establish the position I hold, that no ordinary protector can switch the whole of a flash out of a coil; for a solid copper rod, no matter how thick, is unable to do it, although such a shunt as that would divert every appreciable vestige of signalling or other useful current. The fact is, that to sudden discharges the impedance of a short copper rod may run as high as 100 ohms; and if the discharge current while it lasts is 100 amperes, which is a very moderate value, then we see at once that the E.M.F. needed to drive the current through the rod is 10,000 volts, and this is therefore for an instant the difference of potential between its ends. Such a difference of potential can leap three or four millimetres of air, and is amply sufficient to burst through the insulation of silk-covered wire several times over.

The particular mode adopted in these and such-like experiments for sending a Leyden jar discharge through the rod or across the air gap is quite immaterial. Any convenient plan serves, from simple hand-discharging tongs upwards. But once more I may say that the handiest method of working is to use a couple of jars, to connect their internal coatings with the terminals of an electrical machine, the distance apart of whose terminals regulates the energy of the discharge employed, and to connect the outer coats of the jars to the two ends of the rod, or to the two rods of the universal discharger, or to whatever the flash is wanted to pass through. Instead of a wire tangle or loop, which only typifies the coil of an instrument, and whose only advantage is that one has no compunction in spoiling it, I next proceed to employ an actual galvanometer, and take it as representing anything requiring protection, whether it be telegraph instrument, or cable, or electric light installation of any kind. A galvanometer serves pretty well, because it indicates whether any disturbing current passes round it or not. Notice, however, that it only indicates properly when the discharge really goes round the coil. If it jumps across insulation, and, still more, if it jumps from terminal to terminal, the needle indicates less or nothing. There are, in fact, two things to be aimed at and considered separately in the protection of instruments:

First: the current has to be prevented from passing round the coil, and thus disturbing the magnetism of the needle.

Second: it has to be prevented from jumping across from layer to layer, and so damaging the insulation.

Conduction protection, and insulation protection: both must be attended to. To carry out both these protections completely is not easy; but I apprehend that the protection of the insulation from permanent damage is usually more important than the elimination of temporary disturbing currents which interfere with signalling and make the needle kick while they last.

The galvanometer I use is a simple reflecting instrument, of a pattern devised by Prof. Stuart at Cambridge some time ago. A copper iron junction momentarily touched with the finger demonstrates that it is in a sensitive condition, and could easily be made to furnish its effective constant were it worth while. Connecting its terminals to the outsides of the pair of Leyden jars whose knobs are attached to the machine, separating the machine terminals about the fiftieth of an inch, and turning slowly, we see an attempted steady deflection representing the charging current, interrupted by a series of reverse kicks which occur at every minute discharge; though the sparks of any discharge such as is safe to send through the instrument are too faint to be heard.

Experiment No. 4.

Now insert between the wires leading to the galvanometer a sort of lightning-guard: a pair of plates mounted on a sliding arrangement, so that their distance can be varied (Fig. 1).

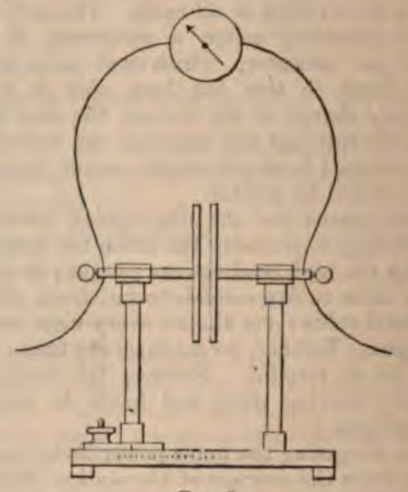

FIG. 1.

Directly the plates approach within sparking distance the galvanometer is apparently protected, and its kicks cease, even though by extending the machine terminals further the energy of the discharges be increased.

Interpolated Experiment No. 5.

Although not immediately important, a little fact may here be noted. If the plates of the guard are pushed still nearer together, or lightly pinched together, so as to leave only a microscopic interval, and almost to obliterate the existence of a spark between them, the needle of the galvanometer again begins to kick at every discharge, but this time wildly and irregularly, and sometimes in the reverse direction. Occasionally these disturbances are very strong, and the spot of light disappears, only to be recovered by tapping the instrument. At the instant when these kicks occur the plates are momentarily short-circuited, as may be proved by replacing the galvanometer by a Leclanché and electric bell. The bell is liable to ring at every discharge, and obviously for the same reason as the galvanometer kicks.

But whereas the bell only proves momentary conducting contact, the galvanometer proves this plus an E.M.F. of occasionally uncertain direction, and always uncertain magnitude. This E.M.F. would seem possibly to have something to do with the infinitesimal spark which temporarily connects the plates, and suggests an E.M.F. like the E.M.F. in an arc.*

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* When I first came across this effect some weeks ago it was with tinfoil inserted between a pair of sparking terminals, and after the kick the tinfoil was often found fused on to one or other terminal. I therefore put it down to a thermal junction between tin and copper, caused and excited by the heat of the spark; and since it was a toss-up which side of the tinfoil adhered (being the side which made a just imperfect enough contact) the fluctuations of direction were easily accounted for, and by special trial this explanation was found to hold good. But then, in this case, after one kick the galvanometer was quiescent at subsequent discharges until the tinfoil was disturbed sufficiently to break the fused contact again.

The experiment described in the text differs, in that there are no two metals, the metal is not fusible, the infinitesimal spark occurs between a pair of similar brass plates, or knobs, and the short-circuiting is quite temporary. I surmised, therefore, that it might possibly

Returning now to experiment 4, which illustrated the protection afforded to a galvanometer by a shunting air gap, it is natural to ask how it can be reconciled with our previous observation, that protection by a single air gap was impossible. But remember that complete protection involved two things—conduction protection and insulation protection ; and the non-deflection of the needle merely shows that no important quantity of electricity now finds its way round the coil. But is the galvanometer therefore safe ? By no means. Its insulation is in imminent danger, and if but moderately energetic flashes are employed we shall see sparks leaping across the coils or jumping from them to the metal work in a very pronounced manner.

Experiment No. 6.

As this is rather rough on the galvanometer, I prefer not to use strong flashes, but to show the existence of the tendency with smaller ones by arranging a safety valve or supplementary minute air gap between the galvanometer terminals ; said safety valve being either a couple of pins brought close together, or a chink cut across a narrow strip of tinfoil pasted on glass.

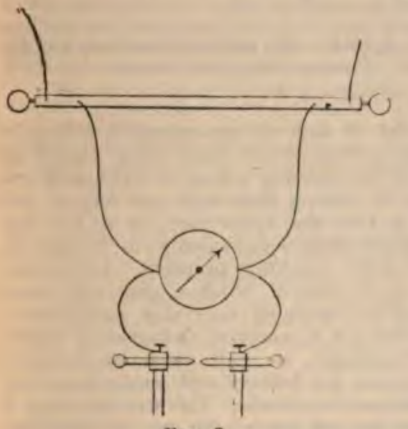

FIG. 2.

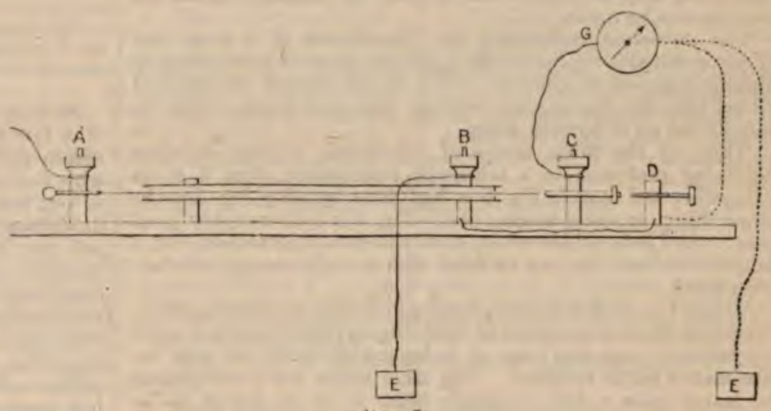

FIG. 3

The high E.M.F.'s which are endangering the insulation, and very likely already jumping in invisible places, can now demonstrate their existence by leaping this chink, and, no matter how the lightning-guard plates are arranged, it is impossible to check the little sparks occurring at the safety valve at every flash. Bringing the plates into absolute contact lessens the brightness of these sparks, but does not stop them ; neither does replacing the plates by a solid bar of metal, as in Fig. 2.

But directly the safety valve is employed to filter off and render manifest the residual effects left by a lightning-guard, the galvanometer needle begins to kick again whenever it acts ; so that, singularly enough, whereas when no safety valve was employed the galvanometer appeared protected by the lightning switch, inasmuch as its needle is stationary, directly the safety valve is added and allowed to sparkle the needle kicks wildly with the very same flashes as before it ignored.

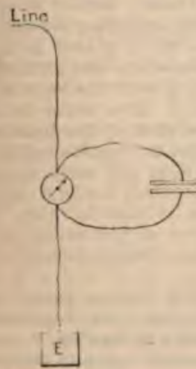

FIG. 4.

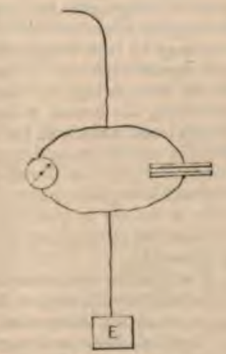

FIG. 5.

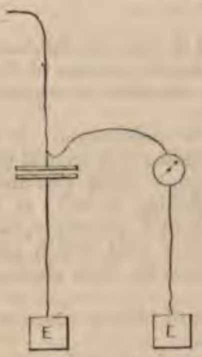

FIG. 6.

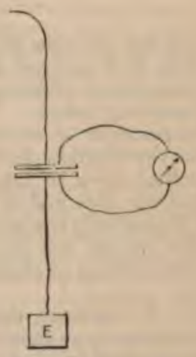

FIG. 7.

This behaviour appears mainly due to the same cause as produced the disturbance in the experiment interpolated above ;* but it may be partly due to the weakening down of the flash by the safety valve so much that a residue of it is able to make its way round the coil, whereas it had previously been too strong, and preferred jumping across insulation in a manner ineffective for galvanometry. The possibility of the occasional truth of this latter explanation is by no means to be overlooked. It often happens that an unprotected galvanometer has its needle less strongly affected by sparks, say, an eighth of an inch long than by sparks the fiftieth of an inch long ; but the reason obviously is that the more violent discharges are not really passing round the coil, but are taking all manner of short cuts.

Experiment No. 7.

Instead of employing a rigged-up model of a protector for the purpose of calling attention to principles, an actual lightning-guard may of course be used, and its behaviour studied in detail. I take, as an excellent instance, a Saunders' protector, so much employed in connection with submarine cables. Its essential part is a fine wire, through which the useful currents have to pass, surrounded by an earth tube with points protruding towards the thin wire, which is stretched by a spring along its axis. The idea is that the tube will relieve the wire of dangerously high potential, while the wire itself will fuse if dangerously strong currents try to pass along it. A supplementary device is a short-circuiting contact, whereby a spring puts the cable to earth directly the wire is fused or in any other way broken. The diagram (Fig. 3) sufficiently represents the instrument. A Jamieson protector is a neat arrangement, involving a fine wire as well as an air gap. There is also some wire coiled on a metal cylinder, but the metal deprives it of all appreciable self-induction.

If I now send very small discharges down the line wire towards a galvanometer protected by this Saunders' guard, they will, if small enough, escape it and pass through the galvanometer, either exciting its safety valve or disturbing its needle, or both. But if stronger flashes are sent the protector begins to act, sparks are seen between fine wire and surrounding tube, and the galvanometer disturbances diminish, as already explained, but those at the safety valve never wholly cease. One is not to suppose that the bigger the flash the less the effect ; that would be a very desirable but somewhat impossible conjecture. The smallest effect is got with the weakest flash which is just sufficient to spark to the protecting tube. Anything stronger or anything not greatly weaker than this gives larger effects.

The fine-wire part of this guard is a good feature and one

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be a phenomenon of greater interest than a mere thermo-electric one. But after the reading of the present paper, Prof. Hughes informed me that he had come across the very same effect, and had satisfied himself that it was only a thermo-electric one. I now think it possible that he is correct, and that the junction is caused by a momentary heat-pimple after the fashion of a Trevelyan rocker or Gore's circular railway. And though this plausible explanation deprives the observation of any theoretical interest, I do not blot it out of the text, but leave it as a record in order to save the time of future experimenters who may easily come across the same thing.

*I do not feel quite certain of the [illegible] thermo-electric explanation.

that may be advantageously introduced into any protector, on the principle of a safety-fuse or cut-out, to eliminate steady or slowly varying currents of too great strength. But the short-circuiting of the protected terminal to earth by the terminal D as soon as the wire is destroyed is perhaps not an unmixed good, for a subsequent earth-seeking disturbance has then two paths between which it may divide—if the connections are made as in Fig. 3—one along the intended earth wire, and the other through the instrument intended to be protected.

True, this latter is a much longer route, but not so infinitely longer that it need convey none, especially if a few short cuts across insulation can be taken.

We see, at any rate, how important it is to make the earth lead as short and direct as possible, and how it is better to connect the thing to be protected to the two binding screws, C and D, of the instrument as indicated by the dotted line rather than to make an independent earth.* If, for instance, a cable be joined inside to C, outside to B, or D, the spring short-circuiting is all good, the only objection being that however prompt the spring may be there is ample time for damage before the contact can be made.

The statement concerning the importance of a short and direct earth also applies to the desirable mode of connecting up lightning-guards in general. They should always be inserted direct into the line circuit between line and earth, never be simply led up to by side wires.

Thus, of the three modes of connecting a plate or other lightning protector to a telegraph instrument, Fig. 4 is an altogether bad mode; Fig. 5 is but little better; Fig. 6 is the same thing, or even worse; while Fig. 7 is a thoroughly good way. As I have said so often, even this is not perfection, but it is quite the best that can be done with a single air gap of whatever kind.

Throw the leads into the protected circuit; let nothing interfere with direct connection of lightning switch to line and earth respectively, and don't use an independent earth for your instrument's earth terminal. The time taken for a disturbance to travel even a foot of copper wire is by no means to be despised, notwithstanding that it travels with the speed of light; and the impedance of every inch tells.

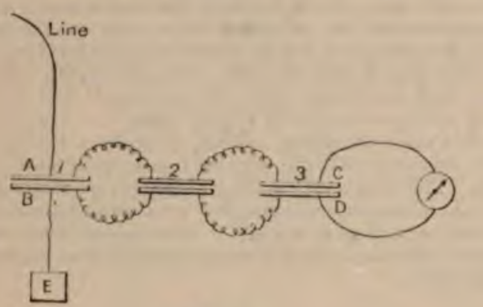

FIG. 8.

I will now describe the principle of my own lightning-guard, and will then connect it to the circuit in place of Saunders's, and show that it affords practically complete protection for both small and big flashes.

The principle is one very easy to understand. It is merely to take the overflow from one protector and give it the chance of another, then to take the overflow from this and offer it another air gap, and so on till nothing is left; at the same time diminishing the overflow from each protector as much as possible by the use of self-induction coils, which impede the violently varying or alternating rushes by their electromagnetic inertia.

Thus, for instance, using a series of plate protectors, we may couple them up as shown in Fig. 8.

Only a small fraction of a sudden shock will escape No. 1; say, a thousandth part, since it is offered the inertia or impedance of the coils as the only alternative. A thousandth of this, again, may escape No. 2, and a thousandth of this, or a thousand-millionth of the whole, is all that is left for the galvanometer. By adding to the series, if it were necessary, it is manifest that a disturbance may be diluted down to any desired extent with the rapidity of a geometrical progression.

I do not, indeed, propose to use plates commonly, simply because they are more bulky than necessary, not so easy to adjust, and not so open to inspection as knobs or points. Moreover, the first or exposed pair of such a series is likely to be damaged by lightning, and when damaged it may be permanently short-circuited or otherwise inconveniently altered in a troublesome and invisible manner. I prefer that the terminals of the first air gap shall be easy to examine, easy to remove, and cheap to replace.

The last air gap of a series I prefer to be very finely adjustable indeed, with screw adjustment, and all of them should be open to inspection, so as to avoid accidental contact on the one hand, or undue air space on the other. I therefore propose simple brass rods for the exposed air gap, adjusted just far enough apart to exclude that disturbing thermo-electric or other effect caused by a spark occurring between their surfaces. All rods must be short, so that heat expansion may not short-circuit them. The theoretically best place to tap off the useful current is from near the tips in contact, so as to tap off a minimum of impedance with a maximum, as in Fig. 9.

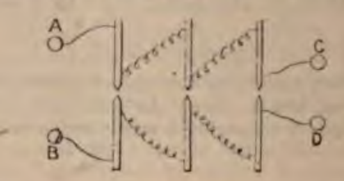

FIG. 9.—A, B, are the exposed or line and earth terminals; C, D, are the protected terminals. Corresponding terminals are lettered the same in all the diagrams.

Making a rough model of such an arrangement, with coils of a few yards of stout guttapercha-covered wire, wound on cotton reels, I tested it by inserting a scrap of extremely fine wire between D and C by holding them with wet fingers, and so on, but was unable to fuse the finest wire, or to feel any disturbance, although great flashes were going to A and B, and the early air gaps were sparking properly. Large condensers, composed of great piles of window glass—the same condensers as I had used for obtaining very slow oscillation—and the discharge of which had a powerful deflagrating effect, were used in this experiment, as well as more moderate capacities, such as a Leyden jar battery and single jars; but still no effect at the protected terminals. This was the stage I had reached when I read my last paper—the one on lightning-conductors, etc., before this Institution.

(*To be continued.*)

PROVISIONAL ORDER.

FORM II.—UNDERTAKERS BEING A COMPANY OR PERSON.

(*Continued from page 375.*)

19. In the exercise of any of the powers of this order relating to the execution of works the undertakers shall not in any way injure the railways, tunnels, arches, works, or conveniences belonging to any railway company, nor obstruct or interfere with the working of the traffic passing along such railways.

20. Seven days before commencing to lay down any electric line, or to supply energy through any electric line in any manner whereby the work of telegraphic or telephonic or electric signalling communication through any wires or lines lawfully laid down or placed in any position may be injuriously affected, the undertakers shall, unless otherwise agreed between the parties interested, give to the body or person for the time being entitled to such wires or lines notice in writing specifying the course, nature, and gauge of such electric lines, and the amount and nature of the currents intended to be sent along the same, and the extent to, and manner in which (if at all) earth returns are proposed to be used, and the undertakers shall conform with such reasonable requirements as may from time to time be made by such body or person as aforesaid for the purpose of preventing the communication through such wires or lines from being injuriously affected as aforesaid.

If any difference arises between any such body or person and the undertakers with respect to the reasonableness of any requirements so made, such difference shall be determined by arbitration.

Provided that nothing in this section shall apply to repairs or renewals of any electric line so long as the course, nature, and gauge of such electric line and the amount and nature of the current sent along the same are not altered.

If the undertakers make default in complying with any of the requirements or restrictions of this section they shall make full compensation to the body or person entitled to any such wire or line for any loss or damage which they may incur by reason thereof, and in addition thereto they shall be liable to a penalty not exceeding £5 for every such default, and in the case of a continuing offence, to a further penalty not exceeding 40s. for every day after the first day during which such default continues: Provided that the undertakers shall not be subject to any such penalties as aforesaid if the court having cognisance of the case shall be of opinion that the case was one of emergency, and that the undertakers complied with the requirements and restrictions of this section so far as was reasonable under the circumstances, or that the default in question was due to the fact that the undertakers were ignorant of the position of the wires or lines affected thereby, and that such ignorance was not owing to any negligence on the part of the undertakers.

21. If it appears to the Board of Trade, on the representation of the Postmaster-General, the local authority, or any other body or person affected thereby, that any works of the undertakers have been or are

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* The dotted line connection in Fig. 3 is the most favourable possible, and it was the one used at the meeting. It is far better than an independent earth for the galvanometer terminal.

in course of being executed otherwise than according to the provisions of this order and the principal Act the Board of Trade, if they think fit, may by order require the undertakers to discontinue or remove such works until such provisions have been complied with, or permit them to continue the same subject to such conditions for the due protection of the party making the representation or other party affected as the Board of Trade may impose, and in case the undertakers make default in complying with any such order, the Board of Trade, if they are of opinion that such default is wilful or unreasonably prolonged, may revoke this order as to the whole or, with the consent of the undertakers, any part of the area of supply.

COMPULSORY WORKS.

22. (1.) The undertakers shall, within a period of two years after the commencement of this order, lay down suitable and sufficient distributing mains for the purposes of general supply throughout every street or part of a street specified in that behalf in the second schedule, and shall thereafter maintain the same.

(2.) In addition to the mains hereinbefore specified the undertakers shall, at any time after the expiration of 18 months after the commencement of this order, lay down suitable and sufficient distributing mains for the purposes of general supply throughout every other street or part of a street within the area of supply, upon being required to do so in manner by this order provided.

All such mains as last above mentioned (unless already laid down) shall be laid down by the undertakers within six months after any requisition in that behalf served upon them in accordance with the provisions of this order has become binding upon them, or such further time as may in any case be approved of by the Board of Trade.

23. Twenty-eight days at the least before commencing to lay in any street any electric line which is intended for supplying energy to any particular consumer, and not for the purposes of general supply, the undertakers shall serve upon the local authority, and upon the owner or occupier of all premises abutting on so much of the street as lies between the points of origin and termination of the electric line so to be laid, a notice stating that the undertakers intend to lay such electric line, and if within the said period any two or more of such owners or occupiers shall require in accordance with the provisions of this order that a supply shall be given to their premises, the necessary distributing main shall be laid by the undertakers at the same time as the electric line intended for such particular consumer.

24. If the undertakers make default in laying down any distributing mains in accordance with the provisions of this order within the periods prescribed in that behalf respectively, they shall be liable to a penalty not exceeding £5 in respect of each such default for each day during which such default continues, and if the Board of Trade are of opinion in any case that such default is wilful and unreasonably prolonged they may, after considering any representations of the local authority, revoke this order as to the whole, or, with the consent of the undertakers, any part of the area of supply, or, if the undertakers so desire, may, after having given an opportunity to the local authority to make representations and objections with reference thereto, suffer the same to remain in force as to such area or part thereof, subject to such conditions as they may think fit to impose, and any conditions so imposed shall be binding on and observed by the undertakers, and shall be of the like force and effect in every respect as though they were contained in this order.

25. Any requisition requiring the undertakers to lay down distributing mains for the purposes of general supply throughout any street or part of a street may be made by six or more owners or occupiers of premises along such street of part of a street, or, where the local authority has the control and management of the public lamps in such street or part of a street, by the local authority.

Every such requisition shall be signed by the persons making the same, or by the local authority (as the case may be), and shall be served upon the undertakers.

Forms of requisition shall be kept by the undertakers at their office, and a copy shall be supplied free of charge to any owner or occupier of premises within the area of supply and to the local authority on application for the same, and any requisition so supplied shall be deemed valid in point of form.

26. Where any such requisition is made by any such owners or occupiers as aforesaid, the undertakers (if they think fit) may, within 14 days after the service of the requisition upon them, serve a notice on all the persons by whom such requisition is signed, stating that they decline to be bound by such requisition unless such persons or some of them will bind themselves to take or will guarantee that there shall be taken a supply of energy for three years, of such amount in the aggregate (to be specified by the undertakers in such notice) as will, at the rates of charge for the time being charged by the undertakers for a supply of energy from distributing mains to ordinary consumers within the area of supply, produce annually such reasonable sum as shall be specified by the undertakers in such notice, provided that in such notice the undertakers shall not specify any sum exceeding 20 per centum upon the expense of providing and laying down the required distributing mains and any other mains or additions to existing mains which may be necessary for the purpose of connecting such distributing mains with the nearest available source of supply.

Where such notice is served the requisition shall not be binding on the undertakers unless within 14 days after the service of such notice on all the persons signing the requisition has been effected, or in case of difference the delivery of the arbitrator's award, there be tendered to the undertakers an agreement severally executed by such persons or some of them, binding them to take, or guaranteeing that there shall be taken for a period of three years at the least, such specified amounts of energy respectively as will in the aggregate at the rates of charge above specified produce an annual sum amounting to the sum specified in the notice, or determined by arbitration under this section, nor unless sufficient security for the payment to the undertakers of all moneys which may become due to them from such persons under such agreement is offered to the undertakers (if required by them by such notice as aforesaid) within the period limited for the tender of the agreement as aforesaid.

If any difference arises between the undertakers and any persons signing any such requisition as to the reasonableness of the amounts specified by the undertakers in their notice, such difference shall be determined by arbitration.

27. Where any such requisition is made by the local authority it shall not be binding on the undertakers unless at the time when such service is effected, or within 14 days thereafter, there be tendered to the undertakers (if required by them) an agreement executed by the local authority, and binding them to take for a period of three years at the least a supply of energy for lighting such public lamps in the street or part of a street in respect of which such requisition is made as may be under their management or control.

SUPPLY.

28. The undertakers shall, upon being required to do so by the owner or occupier of any premises situate within 50 yards from any distributing main of the undertakers in which they are, for the time being, required to maintain or are maintaining a supply of energy for the purposes of general supply to private consumers under this order or any regulations and conditions, subject to which they are authorised to supply energy under this order, give and continue to give a supply of energy for such premises in accordance with the provisions of this order, and of all such regulations and conditions as aforesaid, and they shall furnish and lay any electric lines that may be necessary for the purpose of supplying the maximum power with which any such owner or occupier may be entitled to be supplied under this order, subject to the conditions following (that is to say):

The cost of so much of any electric line for the supply of energy to any owner or occupier as may be laid upon the property of such owner or in the possession of such occupier, and of so much of any such electric lines as it may be necessary to lay for a greater distance than 60ft. from any distributing main of the undertakers, although not on such property, shall, if the undertakers so require, be defrayed by such owner or occupier.

Every owner or occupier of premises requiring a supply of energy shall—

Serve a notice upon the undertakers specifying the premises in respect of which such supply is required and the maximum power required to be supplied, and the day (not being an earlier day than a reasonable time after the date of the service of such notice) upon which such supply is required to commence; and

Enter into a written contract with the undertakers (if required by them so to do) to continue to receive and pay for a supply of energy for a period of at least two years of such an amount that the payment to be made for the same, at the rate of charge for the time being charged by the undertakers for a supply of energy to ordinary consumers within the area of supply, shall not be less than £20 per centum per annum on the outlay incurred by the undertakers in providing any electric lines required under this section to be provided by them for the purpose of such supply, and give to the undertakers (if required by them so to do) security for the payment to them of all moneys which may from time to time become due to them by such owner or occupier in respect of any electric lines to be furnished by the undertakers, and in respect of energy to be supplied by them.

Provided always, that the undertakers may, after they have given a supply of energy for any premises, by notice in writing, require the owner or occupier of such premises, within seven days after the date of the service of such notice, to give to them security for the payment of all moneys which may from time to time become due to them in respect of such supply, in case such owner or occupier has not already given such security, or in case any security given has become invalid or is insufficient; and in case any such owner or occupier fail to comply with the terms of such notice, the undertakers may, if they think fit, discontinue to supply energy for such premises so long as such failure continues.

Provided also, that if the owner or occupier of any such premises as aforesaid uses any form of lamp or burner, or uses the energy supplied to him by the undertakers for any purposes, or deals with it in any manner so as to unduly or improperly interfere with the efficient supply of energy to any other body or person by the undertakers, the undertakers may, if they think fit, discontinue to supply energy to such premises so long as such user continues.

Provided also, that the undertakers shall not be compelled to give a supply of energy to any premises unless they are reasonably satisfied that the electric lines, fittings, and apparatus therein are in good order and condition, and not calculated to affect injuriously the use of energy by the undertakers or by other persons.

If any difference arises under this section as to any improper use of energy or as to any alleged defect in any lines, fittings, or apparatus, such difference shall be determined by arbitration.

29. The maximum power with which any such consumer shall be entitled to be supplied shall be of such amount as he may from time to time require to be supplied with, not exceeding what may be reasonably anticipated as the maximum consumption on his premises: Provided that where any consumer has required the undertakers to supply him with a maximum power of any specified amount, he shall not be entitled to alter that maximum except upon one month's notice to the undertakers, and any expenses reasonably incurred by the undertakers in respect of the service lines by which energy is supplied to the premises of such consumer, or any fittings or apparatus of the undertakers upon such premises, consequent upon such alteration, shall be paid by him to the undertakers, and may be recovered summarily as a civil debt.

If any difference arises betwee
undertakers as to what may b

tion on his premises, or as to the reasonableness of any expenses under this section, such difference shall be determined by arbitration.

30. The undertakers, upon receiving reasonable notice from the local authority requiring them to supply energy to any public lamps within the distance of 75 yards from any distributing main of the undertakers in which they are for the time being required to maintain a current of energy for the purposes of general supply under this order, or any regulations and conditions subject to which they are authorised to supply energy under this order, shall give and continue to give a supply of energy to such lamps in such quantities as the local authority may from time to time require to be supplied.

31. Whenever the undertakers make default in supplying energy to any owner or occupier of premises to whom they may be and are required to supply energy under this order, they shall be liable to a penalty not exceeding 40s. in respect of every such default for each day on which any such default occurs.

Whenever the undertakers make default in supplying energy to the public lamps to which they may be and are required to supply energy under this order, they shall be liable to a penalty not exceeding 40s. in respect of every such default for each such lamp, and for each day on which any such default occurs.

Whenever the undertakers make default in supplying energy in accordance with the terms of any regulations and conditions subject to which they are authorised to supply energy under this order they shall be liable to such penalties as may by such regulations and conditions be prescribed in that behalf.

Provided that the penalties to be inflicted on the undertakers under this section shall in no case exceed in the aggregate the sum of £50 in respect of any defaults not being wilful defaults on the part of the undertakers for any one day, and provided, also, that in no case shall any penalty be inflicted in respect of any default if the court having cognisance of the case shall be of opinion that such default was caused by inevitable accident or *force majeure*, or was of so slight or unimportant a character as not materially to affect the value of the supply.

Price.

32. The undertakers may charge for energy supplied by them to any ordinary consumer (otherwise than by agreement)—

1. By the actual amount of energy so supplied ; or
2. By the electrical quantity contained in such supply ; or
3. By such other method as may for the time being be approved by the Board of Trade.

Provided that where the undertakers charge by any method so approved by the Board of Trade, any consumer who objects to that method may by one month's notice in writing require the undertakers to charge him at their option by the actual amount of energy supplied to him, or by the electrical quantity contained in such supply, and thereafter the undertakers shall not, except with the consumer's consent, charge him by any other method.

Provided also that before commencing to supply energy through any distributing main for the purposes of general supply the undertakers shall give notice to the local authority by what method they propose to charge for energy supplied through such main, and if the local authority become the undertakers under this order they shall give the like notice by public advertisement, and where the undertakers have given any such notice they shall not be entitled to change such method of charging except after one month's notice of such change has been given by them to the local authority and to every consumer of energy who is supplied by them from such main.

33. The prices to be charged by the undertakers for energy supplied by them shall not exceed those stated in that behalf in the fourth schedule in the first and second sections thereof respectively, or in the case of a method of charge approved by the Board of Trade, such price as the Board of Trade shall on approving such method determine.

Provided that if the local authority or the undertakers shall at any time after the expiration of seven years after the commencement of this order make a representation to the Board of Trade that the prices or methods of charge stated in the said schedule or approved by the Board of Trade ought to be altered, the Board of Trade, after such enquiry as they may think fit, may make an order varying the prices or methods of charge stated in the said schedule or so approved as aforesaid, or substituting other prices or methods of charge in lieu thereof, and the prices or methods of charge so varied or substituted shall have effect on and after such day as may be mentioned in the order, as if they had been stated in the said schedule: Provided, also, that the prices and methods of charge for the time being in force may be altered in like manner at any time after the expiration of any or every period of seven years after the same were last altered.

34. Subject to the provisions of this order and of the principal Act, and to the right of the consumer to require that he shall be charged according to some one or other of the methods above mentioned, the undertakers may make any agreement with a consumer as to the price to be charged for energy, and the mode in which such charges are to be ascertained, and may charge accordingly.

35. The price to be charged by the undertakers and to be paid to them for all energy supplied to the public lamps, and the mode in which such charges shall be ascertained, shall be settled by agreement between the local authority and the undertakers, and in case of difference, by arbitration, regard being had to the circumstances of the case and the distributing or other mains (if any) which may have to be laid for the purpose, and the prices charged to ordinary consumers in the district.

Electric Inspectors.

36. The local authority, so long as they are not themselves the undertakers for the purposes of this order, may from time to time appoint, and keep appointed, one or more competent and impartial person or persons to be electric inspectors under this order.

If no electric inspector is appointed by the local authority, or if the inspection of electric lines and works is imperfectly attended to by the local authority, or if the local authority themselves become the undertakers for the purposes of this order, the Board of Trade on the application of any consumer or of the undertakers may from time to time appoint, and keep appointed, one or more competent and impartial person or persons to be electric inspectors.

The duties of an electric inspector under this order shall be as follows :

(*a.*) The inspection and testing, periodically and in special cases, of the undertakers' electric lines and works and the supply of energy given by them.

(*b.*) The certifying and examination of meters ; and,

(*c.*) Such other duties in relation to the undertaking as may be required of him under the provisions of this order or of any regulations under this order.

The local authority, with the approval of the Board of Trade, or the Board of Trade, if the inspector is appointed by them, may from time to time prescribe the manner in which and the times at which any such duties are to be performed by an electric inspector, and also the fees to be taken by him, and such fees shall be accounted for and applied as may be directed by the local authority or the Board of Trade, as the case may be.

37. The local authority may pay to any electric inspector appointed by them under this order such reasonable remuneration (if any) as they may from time to time determine, and such remuneration may be in addition to, or in substitution for, any fees directed to be paid to electric inspectors in respect of their duties under this order or any regulations of the Board of Trade made in pursuance of this order or the principal Act, according as the local authority shall so determine.

38. The Board of Trade may also, if they deem it necessary, appoint any electric inspector or other fit person or persons to enquire and report as to the cause of any accident affecting the safety of the public which may have been occasioned by or in connection with the undertakers' works, or as to the manner and extent in and to which the provisions of this order and the principal Act, and of any regulations under this order, so far as such provisions affect the safety of the public, have been complied with by the undertakers ; and any person appointed under this section, not being an electric inspector, shall for the purposes of his appointment have all the powers of an electric inspector under this order, and the expenses of such enquiry and report, to such an amount as the Board of Trade by their order shall certify to be due, shall be paid by the undertakers, and shall be a debt due from the undertakers to the Crown and recoverable accordingly with costs.

(*To be continued.*)

LEGAL INTELLIGENCE.

TELEPHONE COMPANIES' LIABILITIES.

In the Westminster County Court, on Thursday, his Honour Judge Bayley had before him the case of Causton *v.* The National Telephone Company, in which the plaintiff, the owner of some house property in Leather-lane, sought to recover the sum of £5. 4s. expenses to which he had been put for repairing a roof, which, he alleged, was damaged by the negligence of the defendants' men during the operation of fixing a telephone pole.

A number of witnesses were called on behalf of the company, and all of them denied that they had occasion to go on to the plaintiff's roof, as they did all the work on the adjoining roof, and when it was completed they put the roof into thorough repair.

Mr. Powell was counsel for the defendant company, and contended that the action was brought to extort money out of the company for which they were not liable.

His Honour thought there was no evidence to show that the company's servants did the damage, and therefore judgment would be for the defendants with costs.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The receipts for the week ended May 2 amounted to £4,596; and for the week ended May 9, £2,896.

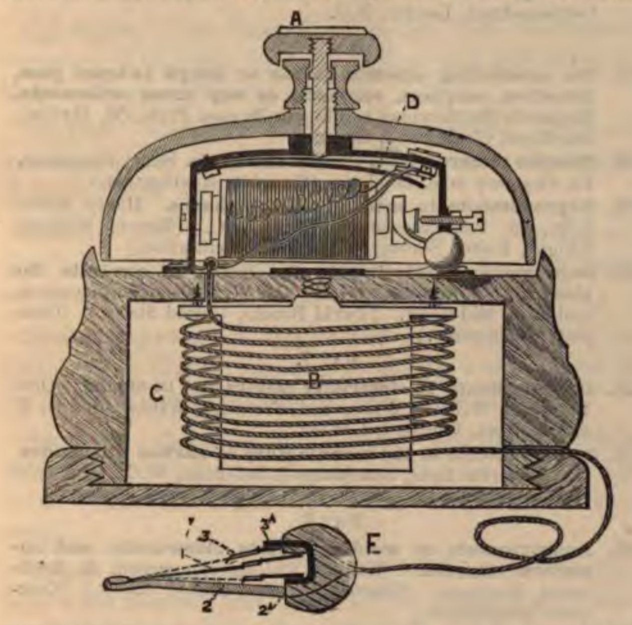
Western Brazilian Telegraph Company, Limited.—The receipts for the week ended May 2, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,515 ; and for the week ended May 9, £2,085.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Anglo-American Brush	—	2¼
— Pref.	—	1¾
India Rubber, Gutta Percha & Telegraph Co.	10	18
House-to-House	4½	5
Metropolitan Electric Supply	—	5¾
London Electric Supply	5	2½
Swan United	3½	5
Crompton & Co., Pref.	—	5½
National Telephone	5	5¼

A PORTABLE COMBINATION BELL.

Messrs. Tumber and Co. are introducing an electric combination bell which, as will be gathered from the accompanying illustration, may in its time play many parts In the first case it may be used as an ordinary table bell. In the drawing A shows the push, when thus used. B is the battery placed in the hollow base-piece of the bell. C is a length of wire which can be taken out when the bell is used as an invalid's bell. The push E is an interesting little thing and serves a double purpose—either a push to be used by the invalid or other person who desires to ring the bell, or as a contact piece for a burglar alarm. It carries a sliding tongue on a spring arm, and its position is shown at 1 when not in use. When making contact by ordinary pressure it takes the position of 2A. When the lever is pushed back and the spring inserted in window or door it is kept closed by pressure of door, on releasing pressure the spring opens, contact is made, and the bell rings till someone breaks contact. It will thus be seen that this ingenious apparatus possesses features considerably differing from those of ordinary electric bells, and features which ought to greatly increase its utility.



CHELSEA.

A very interesting installation of the electric light is to be seen at the Holy Trinity Church, Sloane-street, Chelsea, which was consecrated on Tuesday last.

This is probably the only church yet built in which electricity is relied upon as the sole means of illumination, and is therefore a satisfactory evidence of the growing confidence of the public in the reliability of this system.

The lighting arrangements have been planned and carried out by the Brush Electrical Engineering Company, in conjunction with Mr. J. D. Sedding, the architect of the building, and the effect is excellent.

The nave is lighted by five lanterns, to designs by the architect, suspended with chains from the centre of the roof. Four of these lanterns, which are of wrought iron, gilded, are surrounded with wrought-iron filigree work in the shape of a heart, the outline of which is defined by incandescence lamps. Each lantern is fitted with eight 8-c.p. lamps, and eight 16-c.p. lamps are disposed around the frame of the heart.

The fifth lantern is somewhat of the same construction, but is surrounded by a much more elaborate piece of wrought-iron work in the form of a cross, at each of the four points of which is fixed a trefoil of 16 incandescence lamps.

The lantern is fitted with eight 16-c.p. lamps, making in all 20 16-c.p. on this fitting.

The morning chapel and aisles are provided with lanterns of a less elaborate design, and throughout are fitted with a number of 8-c.p. and 16-c.p. lamps.

The switches are so arranged that the whole of the 16-c.p. lamps can be turned off or on at once, and the same with those of 8-c.p., thus enabling the amount of light to be adjusted according to requirements. Besides this, each pair of lanterns is controlled by a separate sub-switch and double-pole fuse, so that should anything happen to put one lantern out not more than one other would be affected.

The entrance lobbies, gallery stairs, corridors, vestries, musicians' galleries, and parish-room are all lighted with groups of three and four lamps, arranged on artistic wrought-iron electroliers designed and manufactured by the Brush Company.

The whole of the lights are controlled by switches fixed in a polished oak box with plate-glass doors under the gallery.

When completed, the installation will consist of 130 16-c.p. incandescence lamps, and 102 8-c.p. ditto.

The supply of current is derived from the mains of the Chelsea Electricity Supply Company, whose station is situated in Draycott-place.

COMPANIES' MEETINGS.

MAXIM-WESTON ELECTRIC COMPANY.

The ordinary meeting of this Company was held on Friday at the Cannon-street Hotel.

Mr. J. Blades Gooding, who presided, stated that the Directors had delayed calling the shareholders together in anticipation of being able to report the result of the action against the managing director of the late company, but that action was still pending. In consequence, the Directors were unable to comment upon matters which were still the subject of litigation, and refrained from now giving to the shareholders so full an explanation of affairs as they could wish.

The **Chairman** briefly moved the adoption of the report, which was seconded by **Mr. Swaby.**

Several shareholders protested against the adoption of the report without some statement from the Directors, and the **Chairman** said the position of the Company was a most disastrous one. They were doomed to bankruptcy, because they had a heritage of bad debts and litigation, which they could not get over. He expressed the opinion that there were professional wreckers among the shareholders.

The report was adopted.

ANGLO-PORTUGUESE TELEPHONE COMPANY, LIMITED.

The third ordinary general meeting of the shareholders of this Company was held on Thursday in last week at 53, New Broad-street, E.C.

Sir Alexander Armstrong, K.C.B., F.R.S., presided, and, in moving the adoption of the report, congratulated the shareholders on the satisfactory state of the Company generally. There had been a steady increase of income, and also of subscribers. The profit on the year's working amounted to £5,361, and after deducting £600 paid for debenture interest and adding £5,827 brought forward from 1888, there remained a balance of £10,589 to the credit of profit and loss account. Out of that they had paid an interim dividend of 4 per cent., and it was now proposed to write off £1,500 discount on debentures issued and to place £6,000 to the reserve fund, leaving a balance of £1,089 to be carried forward. The expenditure on capital account for the year had been £9,731. That expenditure had been entailed in consequence of the great expenses attending the erection of a new exchange, and also because the Company were obliged to reconstruct many of their existing lines. The paying subscribers in Lisbon on December 31 last numbered 985, from whom they obtained a gross annual value of £7,180, while those in Oporto numbered 870, from whom a gross annual value of £4,708 was produced, making in all an income of £11,888, or a total increase in subscribers of 222, and in value of £1,320 over the preceding year. He might further add that up to April 15 last the income had increased to £12,204, and since that date there has been a further increase of £316, so that the total income of the Company stood at £12,520. Considering the recent political disturbances in Portugal and the hostile feeling towards every English enterprise in Portugal, he considered the result very satisfactory.

Mr. C. L. W. Fitzgerald seconded the motion, which was carried. The meeting then proceeded to re-elect the retiring auditors.

WEST COAST OF AMERICA TELEGRAPH COMPANY, LIMITED.

The thirteenth ordinary general meeting of this Company was held on Wednesday, at Winchester-house, Old Broad-street.

Mr. Alfred Marshall presided, and in moving the adoption of the report stated that the gross earnings for the year had been £83,568 (compared with £64,583 in the previous year). This was a handsome return, and they attributed it to the good business which had been done on the west coast, to the formation of a large number of joint-stock companies and the speculation in nitrate, and to the interruption to the cable on the east coast, which competed for the traffic from Valparaiso. They had mentioned in their report the subject of the threatened competition. The concession under which their cables were worked was not a monopoly, and it was merely a permission of the Chilian Government, which had exercised its right of giving permission to others to lay a cable parallel to the Company's. In February, 1877, the Chilian Government gave permission to Don Enrique Gandarillas to lay a cable. No doubt this was in the interest of the Central and South American Telegraph Company, their neighbour, with whom they were still working under a joint agreement. This concession expired in February, 1889, but it was then renewed for a year ; and last February it was again renewed, the period ot the concession being extended to February next. In the present year, too, the Central Company had sent out a repairing steamer, on the arrival of which the retaining fee which they had paid to this company would cease. Last month there appeared a statement in an American paper that the Central Company had asked their shareholders for an increase of capital to the amount of 1,000,000dols. United States currency, for the purpose of laying cables parallel to the Company's. About the same time, too, the Central Company notified them that the joint working agreement, which was dated July, 1882, and which was terminable at six months' notice, would expire on the 1st of October next. They did not believe it possible that a cable could be laid by that date, but they believed it was quite possible for a cable to be manufactured, sent out, and laid before the expiration next February of the concession given to Mr. Gandarillas. They had thought it very important to inform the shareholders at the earliest moment of the threatened competition. They hoped before the directors of the Central Company took such a serious step that they would suggest some new working arrangement with the West Coast Company, who were quite prepared to treat with them, as they already knew. He concluded by moving the adoption of the report.

Mr. Henry Roberts seconded the motion.

In reply to questions, the **Chairman** stated that all the European messages carried by the Company also went over the lines of the Central Company, which was an American company. There were two lines to Valparaiso—the Galveston route (their own), and the Eastern route, *via* Lisbon. He believed that their Company had 80 or 90 per cent. of the traffic, their cables being in such good working order. If the cables referred to should be laid they would have to try and get some European traffic by the competing route. They would, for instance, endeavour to obtain Lima telegrams over their own line, *via* Buenos Ayres, Rio, and Lisbon. The local traffic would, of course, be competed for, and this would entail a reduction of rates. They had no doubt that if the Central Company were in earnest they would obtain the capital they required to lay the new cables. The agreement with that company must have worked with satisfaction to them up to now, or it would have been terminated before. As to the fees of the Directors being too large, he was sometimes four or five times a week attending to the business of the Company, and his colleagues were also available at any moment. He would be ready to start for the west coast of America at any time if personal negotiations with the Central Company had to be entered upon. The question of strengthening the Board had already engaged their attention.

The motion was then adopted, and the bonus recommended was afterwards declared, making the return 6 per cent. for the year.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY, LIMITED.

The nineteenth ordinary general meeting of this Company was held last Friday at Winchester-house, Old Broad-street, E.C., under the presidency of Mr. W. S. Andrews.

The **Chairman** said they met under not quite such adverse circumstances as on the last occasion. At that time they were expecting, owing to interruptions, reduction of rates, and other causes, an exceedingly bad half-year's traffic, and they were threatened with early competition both north and south of their system. He was glad to say the apparent blackness of those circumstances had been a good deal mitigated. The receipts for the half-year very much increased towards the end. They all knew that a short time ago they went to sleep under an Empire in Brazil, and woke up under a Republic ; and a revolution like that necessarily led to a considerable interchange of telegrams, and the last two months of the half-year were very high as compared with the previous four months, which were very low. The outcome of the half-year compared unfavourably with the corresponding half-year—the half-year in which they took the extraordinary total of £110,000, which was the highest they had ever had, arising partly from high tariffs, partly from the high rate of exchange, and partly from the enormous commercial activity and great speculation that prevailed during the half-year, and which recorded the highest tide-mark in respect of telegraphic revenue. However, in the past half-year they had managed to scrape together receipts of £86,403, which was nothing like so large a decrease as they were all anticipating when they met last. In expenses, the only considerable increase was under the head of ships, which was £7,281. The working expenses amounted to £40,391, as against £31,220. The increase under the head of ships arose from the necessity of recalling the "Norseman" for repairs, and chartering a cable steamer to fill her place. The effect of their operations was that, including the amount brought forward, £4,072, and the dividend received from the Platino Company on their shares, £7,379, they had a balance to credit of revenue of £57,462, from which has been deducted £13,500 for debenture interest, £7,500 for the renewal fund, and £5,600 for the debenture redemption fund. This left an available balance of £30,862, and the Directors now recommended the payment of a dividend of 6s. per share free of income tax on the ordinary shares for the half-year, making, with the dividend paid in November, £4 per cent. for the year, leaving a balance of £3,248 16s. 6d. to be carried forward.

The motion was seconded by **Mr. H. Weaver**, and carried unanimously.

The **Chairman** moved, and **Lord Richard Browne** seconded the re-election of Mr. C. W. Earle to the board, which was agreed to, as was also the re-election of Mr. Weaver, on the motion of the **Chairman**, seconded by **Major Wood.**

Mr. Peto proposed, and **Mr. Machell** seconded the re-election of the auditors, Mr. John Weise and Mr. J. C. Griffiths, which was carried.

PROVISIONAL PATENTS, 1890.

MAY 5.

6924. **Improvements in electrical batteries.** Henry Thomas Eagar and Richard Philip Milburn, 433, Strand.

6939. **Improvements in connecting telegraph and telephone wires.** William Henry Crawcour, Gordon Villa, West Bridgford, Nottingham.

6943. **Improvements in electric arc lamps.** Emil Fischinger, 6, Bream's-buildings, London.

6945. **An improved electrical switch.** Joseph Appleton, 115, Cannon-street, London, E.C.

MAY 6.

6959. **For connecting electric globes or lamps to scarf pins, brooches, earrings, coronets, or any dress ornaments.** Benjamin Matthewman and Edwin Dawson Pride, 50, Myddelton-street, Clerkenwell, London.

7003. **Electric motors.** Louis Duncan and Hiram Henry Carpenter, 77, Chancery-lane, London. (Complete specification.)

7038. **Improvements in mechanical telephones.** Henry Harris Lake, 45, Southampton-buildings, W.C. (Marcus Whitney Knight, United States.) (Complete specification.)

7044. **Improvements relating to the lining of conduits for electric conductors.** Henry Harris Lake, Southampton-buildings, Middlesex. (David Brooks, United States.) (Complete specification.)

MAY 7.

7125. **Improvements in electricity meters and in clocks.** Otto Romanze, William Weise, and Frederick William White, 4, South-street, Finsbury, London.

7132. **Improvements in the manufacture of carbon electrodes.** Henry Harris Lake, Southampton-buildings, W.C. (Lacombe and Cie., France.)

MAY 8.

7185. **Improvements in welding metals electrically and apparatus therefor.** William Phillips Thompson, 6, Lord-street, Liverpool. (Charles L. Coffin, United States.) (Complete specification.)

7186. **Improvements in welding metals electrically and apparatus therefor.** William Phillips Thompson, 6, Lord-street, Liverpool. (Charles L. Coffin, United States.) (Complete specification.)

7196. **An electric door lock.** Heinrich Grefen, 433, Strand, London.

7209. **Improvements in electric arc lighting.** Llewellyn Saunderson, 24, Southampton-buildings, London. (Date applied for under Patents Act 1883, Section 103, 4th December, 1889, being date of application in United States.) (Complete specification.)

MAY 9.

7219. **An electric supply meter.** John Perry, The Finsbury Technical College, Leonard-street, London.

7225. **Improvements in the construction of electric bell-pushes.** Thomas James Baker, The Yews, Albert-road, Stechford, near Birmingham.

7239. **Improved switch for electric lighting.** John Woolley and Walter Edward Hunnex, 19, Morland-road, Croydon.

SPECIFICATIONS PUBLISHED.

1878.

3988. **Electric lighting.** Lane-Fox. (Sixth edition.) 8d.

1880.

3880. **Distribution of electricity.** Jensen (Edison), (Third edition). 8d.

1882.

3576. **Distributing, &c., electricity.** Hopkinson. (Third edition.) 8d.

1889.

4484. **Electric currents.** Mordey. 8d.

6520. **Electrical motors.** Thompson (Günther and another.) 6d.

7883. **Electro-motors.** Cuttriss. 6d.

7993. **Autographic telegraphs.** Allison (Robertson). 6d.

9096. **Telephonic switch boards.** Jackson and Sinclair. 8d.

9241. **Electric meters.** Swinton. 11d.

9713. **Electric conductors.** Lorrain. (La Société d'Exploitation des Cables Electriques, Système Berthoud, Borel et Cie.) 6d.

9917. **Electrical switches.** Nicholson. 6d.

9945. **Arc lamps.** Hanson. 8d.

10933. **Electro-motors.** Von Dolivo-Dobrowolsky and Allgemeine Electricitäts Gesellschaft. 8d.

1890.

1037. **Telephones.** Bowles. 6d.

3455. **Electric secondary batteries, &c.** Lake (Ewing). 8d.

3840. **Dynamo electric generators.** Currie. 8d.

NOTES.

Electrical Refining.—Two dynamos of 125 h.p. are in use at Anaconda, Mont., for refining.

Electricity v. Horses.—At St. Louis, on July 4, there will be 4,665 horses and mules for disposal, displaced by electric traction.

Calcutta.—The offices of the British India Navigation Company, of Calcutta, are to be lighted with 300 lamps by Messrs. Mavor and Coulson.

Station Lighting.—Tithebarne Station, Liverpool (Lancashire and Yorkshire Railway), is to be lighted by electricity from August next.

Dover.—The town clerk of the Dover Town Council reported at the last meeting that the electric light order was now in proper form for going through.

Southampton.—A copy of the license granted to the Southampton Electric Lighting Company was received at the last meeting of the Southampton Town Council.

Spanish Cable.—The Spanish Minister of Public Works invites tenders for laying a cable between Spain and Cuba. This will be 5,000 miles long—the longest in existence.

China Telegraphs.—The French Minister for Foreign Affairs has received intelligence of the opening of a telegraph line connecting Tonquin with China by way of Yunnan.

Dublin Gas.—An interesting and important item to Corporation, public, and electrical engineers is that the price of gas in Dublin has been advanced 3d. per 1,000 cubic feet.

Street Railway.—Rochester, New York State, has a tramway company which has ordered 100 motors and 100 new vestibule cars for its line to be in operation by November next.

German Telegraphs.—Eight million marks have been voted for extension of German telegraphs and telephones. A considerable part of this will be for placing wires underground.

Lightning Guard.—An interesting feature in connection with the Edinburgh Exhibition is that a large part of the buildings is electrically protected upon Prof. Oliver Lodge's wire cage system.

American Telegraphs.—The Western Union Telegraph Company, of America, has purchased for 100,000dols. all the telegraph lines belonging to the San Antonio and Aransas Pass Railway Company.

Berlin Tramways.—The first electrical tramcar in Berlin commenced running on Tuesday from the Behren Strasse to Kreuzberg. People were amused to find inside the cars the words in English, "No smoking."

Magnetic Separators.—Two Wenström magnetic separators have been sent to Nepaul from the Anboga Works in Sweden. Each separator has a dynamo attached giving 50 volts and four amperes for magnetisation.

Birmingham Exhibition.—The committee of the electrical exhibition at Birmingham have sent a cheque of £101. 7s. 2d. to each of the three hospitals, the General, Jaffray, and the Queen's, to which the surplus was to be given. The total receipts were £12,059.

Thomson-Houston Railway.—The new Thomson-Houston electric locomotive for use on the West End street railway of Boston, Mass., has been constructed and is now in use. It is fitted with an air brake worked by a small motor fixed in one corner of the engine car.

Electric Lighting in London.—Even the general public must now fast be becoming convinced that electric lighting in London is really going ahead. In the report of the Highways Committee of the London Council on Tuesday there were applications for the laying of mains in no less than 152 streets, all west of the Law Courts.

Electrical Supplies.—Messrs. Appleton, Burbey, and Williamson have purchased the whole of the manufacturing business of Mr. F. Geere Howard, of Cleveland-street, Fitzroy-square, W., and have transferred the plant to their works at 57c, Hatton-garden, E.C., which have been enlarged to enable them to meet the growing demand for electrical supplies.

Lightning in a Watchmaker's Shop.—During a heavy thunderstorm a flash of lightning struck a house in the valley of the Lac de Joux, Switzerland, and caused considerable loss in a curious manner. No great damage was done, but the demagnetisation of the innumerable small steel pieces used in the industry caused an expense of some two thousand francs.

African Telegraphs.—A number of non-commissioned German officers, says *Kuhlow's*, who have received instruction in telegraphy, will shortly be despatched to East Africa to join the Wissmann forces, in order to establish an improved news and communication service. They will take with them field telegraph apparatus and supplies. It is intended, in the first place, to connect by telegraph the several garrisons and outposts in the same way as the Italians have already done in Abyssinia.

Norwich.—On the occasion of Mr. Gladstone's visit to East Anglia, a great meeting was held in the Agricultural Hall, Norwich. The hall was very brilliantly lit by electricity, every point being brought well within view, whilst the coolness of the atmosphere, except in the very topmost positions in the building, was the subject of general congratulation. Messrs. Laurence, Paris, and Scott, Limited, of the Gothic Works, King-street, Norwich, carried out the lighting under the superintendence of their engineer, Mr. W. B. Sisling.

Paddington.—The Paddington Vestry on Tuesday passed the following resolution: "That the Vestry's solicitor be instructed to withdraw the opposition to the application of the Metropolitan Electric Supply Company for a provisional order." It is believed that this resolution will have no effect, as no intimation was to be given to the Board of Trade. There is, however, to be a meeting on the 29th inst., which, so far as can be gathered, has been formally called, and probably some formal resolution will then be arrived at.

Another Fraud.—Electrical firms are warned against being defrauded by a foreigner representing himself to be in possession of a valuable primary battery invention, but wanting a little money to make up a sample. The individual in question pretends to be a doctor of physics in an university in Vienna, is young, tall, has black hair combed quite down over the forehead, has a strongly marked "port-wine" mark on one cheek, and speaks English very badly. The mention of these particulars may prevent others being swindled, as at least one firm has been.

Explosive Mixtures.—It is stated that the president of the Midland Institute has succeeded in exploding a mixture of firedamp and air by suddenly breaking the bulb of an incandescent lamp. This emphasises the fact that it will be better to rely on a disconnecting switch for electric miners' lamps which should cut out the lamp if the outer glass were damaged, rather than rely in the least upon the prompt extinction of the filament in case of breakage. In some forms this has been proposed by air pressure between the lens and the lamp bulb maintaining the contact.

Electric Burglar Catching at Paris.—An enterprising wine merchant in the Rue Secretan has made his fifth capture of burglars under the following circumstances. There is no *concierge* for his premises, so he has caused his shop to be connected with the room occupied by his waiters by means of an electric wire. When the burglars enter, ringing of the bell takes place in the waiters' room, and they are thus enabled to capture the intruders. The wine merchant's experiment has been so successful hitherto that several other traders in the vicinity have been imitating his ingenuity.

Lecture at Sidcup.—Under the auspices of the Sidcup and District Tradesmen's Association, an electrical entertainment was given at Sidcup on Monday evening by Mr. S. B. McClellan, of the firm of Messrs. Price, Talbot, and Co., Limited, electrical engineers, 26, Ludgate-hill, London. Mr. E. G. Parr, of New Eltham, presided, and Mr. McClellan was assisted by Mr. T. Berrett and Mr. A. Slater. The discovery of electricity having been traced, Mr. McClellan devoted time to the theory of electricity, and exhibited numerous experiments with statical machines, vacuum tubes, bells, and kindred apparatus.

Birkenhead.—The provisional order submitted by the Parliamentary Committee of the Birkenhead Town Council to the Board of Trade has been returned so much altered and modified that it has been necessary to call a meeting to consider the matter again. A resolution was proposed that notwithstanding the numerous alterations, it is desirable that the order should be proceeded with. The Mayor said they would have only themselves to blame if they now threw the matter up and allowed a private company to come forward and take advantage of their supineness. The motion was carried with only two dissentients.

Steering by Electricity.—An officer on board the German ironclad "Preussen," in conjunction with the engineer of that ship, has, says a correspondent of *Industries*, invented an electrical steering apparatus about which there is much talk just now in naval circles. By means of this apparatus the captain can control the rudder from the bridge or from any point on the deck—an important advantage in the noise of a storm or in action. That the invention is regarded by the authorities as one likely to prove of great importance is shown by the fact that the ironclad "König Wilhelm," on the very next day after her return with the Mediterranean Squadron, was sent to sea to test it.

Street Traction.—Mr. Rosenbusch, of Munich, proposes a new and sweeping change in the organisation of city streets for the better dealing with street traffic. He proposes to entirely do away with cellars extending under the foot walks, terming these hot beds of disease. In place of this he would have a passage the floor of which would be on a level with the streets. The side walk would be erected above this passage in the form of a gallery, completely isolated from vehicular traffic below, bounded by a railing with the shops on this level. In the passage drainage, telephone, and electric light wires could be laid, and a track for electrical tramways, whose speed could be much greater than at present. It is suggested that perhaps some new city in the Far West will organise itself upon this scheme.

A Precursor to Franklin.—*Ciel et Terre* mentions an Italian precursor to Franklin, a doctor of the name of Ignario, who in 1746, at Padua, produced a book on "Electricity and the Electric Force of the Body." In this volume he describes the effect of the Leyden jar and says: "Who shall deny that that lightning is other than a subtle electric matter carried to the greatest degree of force? What fatal surprise would await the experimenter who, having found the artificial means of producing lightning, should succumb a victim to his curiosity." In the face of language so precise it is maintained that the name of Ignario should be placed in the front rank in the history of atmospheric electricity, for it was not till 1748 that the Abbé Nolet pointed out the analogy and strict relation existing between the phenomena of electricity and lightning, an analogy proved later on by Franklin.

Telephone and Telegraph Apparatus.—We have received from Mr. G. Wehr, of 35, Alte Jacob Strasse, Berlin, very complete lists of handsome and very moderately priced telephone apparatus. These include separate and double telephones, and box-shaped telephones, with various patterns of microphone transmitters. Many and varied types of telephone installations are given for office, ship, hotel, or central exchange use, and some handsome pieces of furniture are illustrated. The firm make a great speciality of magneto bells for telephone service, and several patterns of these are shown. The house telegraph catalogue is equally complete, and contains, besides the necessary apparatus, numerous highly ornamental bell pushes and contacts. A third catalogue shows telegraphic apparatus for ordinary use and for railways. A special feature is made of a universal lightning discharger for protecting line wires.

Design to Assassinate a French Electrician.—One of the wonders of the week in Paris is the disclosure of a mysterious plot to assassinate the well-known electrician Dr. Cornelius Herz. In 1888 an advertisement in the *Figaro* appeared asking for an agent to carry through a difficult and dangerous undertaking. Amiel, a former police commissary, answered it, and having discovered that the undertaking was to assassinate Dr. Herz took a room near and pretended to seek means. He obtained the advance of 15,000f. and then departed for Buenos Ayres. Here attempts were made on his own life instigated, he is convinced, by the disappointed plotter, so returning to Paris on March 4th last, he submitted the matter with documentary evidence to Dr. Herz, who has published the affair. It is not known who the would-be assassin is, but Dr. Herz is one of the wealthiest men in France and has enemies as well as numerous friends.

Flashing Signals.—The process of flashing lights to imitate the telegraphic signals is now so general that it might also now be thought to have been a simple and axiomatic discovery. It was not so by any means. Admiral Coulomb, who some thirty years ago as a lieutenant in the naval service invented and patented the system, suffered many years' official neglect before what has proved to be one of the most useful inventions in naval practice was adopted. For this invention he received the sum of £500, hardly more than his patent expenses, which amounted to £380. Afterwards a second £500 were given in full discharge for use of the invention, which is now universal and must have saved money and lives without count, a paltry return considering the sums of £25,000 with yearly payments recently made to inventors of less useful apparatus. An attempt is being made to press for a more adequate return from the Treasury for an invaluable service.

Frankfort Exhibition.—The preparations for the electrical exhibition to be held at Frankfort-on-Main next year are being rapidly pushed forward. Among the numerous applications already received the Swiss firm of Oerlikon and Co. is noticeable. In connection with electric shipbuilding, the firm of Escher Wyss and Co., of Zurich, will send a large electric boat, driven by accumulators and capable of carrying 100 persons. This boat, which will be artistically fitted, and furnished, of course, with electric light, will ply on the River Main to serve as aid in the traffic between the interior of the city and the eastern part, where the exhibition is situated. In view of the scope offered for the use of an electric boat service on the lakes in South Germany, Switzerland, and Austria, this part of the proposed exhibition will be regarded with especial interest. We also understand that the Electro-Technical Society of Frankfort have decided to organise an international electrical congress, at the time of the exhibition, at which numerous practical questions will be discussed. The importance of the proposed Frankfort exhibition is being widely recognised in technical circles.

Electric Roads in America.—The Rochester Railway Company, of Rochester, New York, is relaying its track with steel rails on concrete foundations for electric traction. A contract has been let to the Gilbert Car Company, of Troy, for 100 cars, 18ft. long, with enclosed platforms or vestibules for this line, and a contract for 25 miles of steel grooved rails has been given out. The company are intending to extend the line. The City and Suburban Railway Company, of Memphis, Tennessee, has purchased the Prospect Park Line, 10 miles long, and will equip it with the Thomson-Houston electric system. The Crescent Railway, of New Orleans, has arranged for the construction of its cars by the Electric Traction and Manufacturing Company. The Gainesville (Texas) Street Railway is rebuilding its track, and laying about 10 miles of extension to all be equipped with electric cars. The Kansas and Blue Valley Street Railway is intending to spend 25,000dols. on an electric plant. An electric railway connecting the towns of McMinnville and Dayton, Oregon, is projected. Duluth, Minnesota, will adopt electric traction this summer. An electric street railway company, with a capital of 200,000 dols., has been organised at Indianapolis.

Croydon.—At the meeting of the Croydon County Council last week, Councillor Oelrichs, who was armed with a formidable bundle of notes, rose in accordance with notice to move that the General Purposes Committee be requested to consider and report whether, under existing circumstances, they can recommend the Council to seek electric lighting powers in the next session, and if so, what steps they would advise being adopted. After pointing out the importance of the question, he remarked that his proposition was almost exactly the same as the one he had brought forward last year. It was therefore objected to as out of order, but Councillor Miller took the wind out of the sails of the mover of the motion by saying he thought he could say the committee would accept, and the Mayor therefore remarked to Councillor Oelrichs that he had got all he wanted. Councillor Oelrichs still wished to make his speech, but the Mayor, who said he had frightened the Council by his large collection of notes, put the motion, saying the speech might follow. The motion was, however, carried without the speech. It may therefore be considered that the Croydon authorities do not feel themselves in want of conversion, and are disposed to encourage the adoption of the electric light next session.

Brussels.—La Société Electrique, who supply the Julien accumulators in Belgium, have lately put up an important installation in the palace of the Comte de Flandre at Brussels. The lighting comprises three arcs in the courtyard, and 900 incandescent lamps disposed as follows: 178 in the library, dining-room, billiard-room, and the Prince's private apartments; 574 in the reception-rooms, 27 in the guests' bedchambers, 28 in the children's rooms, and 93 in other parts. The original generating machinery, placed in the basement, consisted of a 4 h.p. engine to charge a battery of Julien accumulators to supply the private rooms only. This has been increased by the addition of a 20-h.p. engine to charge a battery of 36 accumulators (of 240 kilos); these accumulators are charged every week according to requirements. They give an average of 10 ampere-hours per kilo (4·5 ampere-hours per lb.) and 1·90 volts. The lighting, which, it is stated, is furnished entirely by the accumulators, can be obtained at any hour of the day or night without starting the machines. The installation has been so successful that the Comte de Flandre is making arrangements for the extension of the supply to the whole palace, stables, kitchens, and servants' offices, which will bring the total up to 1,500 lamps.

Death of Carl Frischen.—The death is announced on the 8th inst. of Herr Carl Frischen, chief engineer to Messrs. Siemens and Halske, of Berlin. He was born at Bremen in 1830, and apprenticed at an engineering works in that town, subsequently studying at Hanover. He afterwards entered the service of the Hanoverian Government, and in spite of his youth was entrusted with the superintendence of the erection of railway telegraphs, and shortly afterwards he was appointed chief of the Hanoverian telegraphs. In that capacity he was the inventor of numerous practical arrangements and improvements. In 1856 Mr. Frischen invented electromagnetic duplex telegraphy simultaneously with Mr. Werner Siemens, and in that way his name became more widely known. In 1867 Mr. Frischen entered the telegraph service of the North German Confederation, and for some years held in Berlin the office of chief telegraph engineer, but afterwards, in 1870, accepted an offer of Messrs. Siemens and Halske to enter their service as chief engineer. His inventive capacity, combined with his practical turn of mind, found full scope in the large and diversified works of the firm, extending to all branches of electricity. About four years ago his health suffered from the effects of a serious operation, and although appearing restored a fatal result has unfortunately ended an interesting and useful life.

Electric Investment.—A company has been brought out, the list closing to-day, under the name of the Electric and General Investment Company. The purpose, as announced, is forwarding the development of promising electrical undertakings in lighting, traction, power, or other industrial uses. In all large undertakings there are three distinct stages, the first, the finding of the capital and preliminary work; the second, the manufacture of the plant; and the third, the exploiting of this when carried out. During the present period of great electrical promise contractors who have to do with the second of these processes—the manufacture of apparatus— are constantly approached by persons with schemes, ideas, concessions, or patents. It is not their principal work to judge of these schemes and to find the capital for them, but to carry out orders for plant and to receive money for the same, yet this is what they are constantly asked and sometimes obliged to do. The company mentioned has been formed to carry out these objects specifically, to underwrite, to exploit concessions, to examine, report upon, and negotiate good schemes. The company do not intend to manufacture. No promotion money has been paid. The capital is fixed at £200,000, of which £100,000 in £5 shares are issued with 100 founders' shares of £5, the latter taking half the profit when the profit is over 10 per cent. The name of Mr. Emile Garcke is among the directors.

Site for Dublin Central Station.—At the last meeting of the Dublin Corporation, Mr. J. L. Robinson moved the adoption of the report of the special committee on electric lighting, which was as follows: "Your committee beg to report that, having considered several suggestions as to a site for a central station, they have come to a conclusion in favour of one in Fleet-street, where the premises Nos. 49 to 52A inclusive—part of the city estate—are at present unoccupied. Mr. Dudgeon estimates the letting value on lease for 150 years, with covenants to build at a cost of £4,000, at a rent of £88. The houses Nos. 53 to 58, Fleet-street, and 18 and 19, Anglesea-street are also the property of the city, and when the leases expire would be available, if required, for future extensions, and your committee beg to recommend that no lettings be made which would prevent any of these premises being utilised by the Corporation for the purposes of the installation. For the borrowing of the proposed loan of £50,000 application has been made to the Local Government Board for sanction, as prescribed by the Electric Lighting Act of 1882. At the request of your committee, Councillors Robinson and Mayne, accompanied by the Very Rev. Gerald Molloy, D.D., and the borough surveyor, have recently visited some of the most important installations, and presented a report giving the latest particulars as to numerous details. This has been printed for the information of members." Mr. Healy seconded the motion, which was passed.

Halifax and Bermudas Cable.—On Wednesday, at the invitation of the chairman and directors of the Halifax and Bermudas Cable Company, Limited, a number of gentlemen visited the steamship "Westmeath" at Greenhithe, which is about to proceed to Halifax and Bermuda for the purpose of laying the cable. The party was conveyed by a special steamer from Westminster Bridge, and among those present were Sir Alexander Armstrong, K.C.B. (chairman of the company), Mr. Isaacs, M.P. (deputy chairman), Mr. Sydney Gedge, M.P. (chairman of Henley's Cable Company, by whom the cable has been made), Mr. Latimer Clark, C.E., Mr. Graves, C.E. (engineer-in-chief to the post office), Mr. James Hay (secretary), Mr. Bristow, Mr. Glynn, Mr. C. Seymour Grenfell, and Mr. Barnard. The visitors were conducted over the vessel by Captain Stiffe, the engineer-in-chief, who explained the various points of interest in connection with it. The carrying capacity of the vessel is about 4,500 tons, and everything included it has about 4,000 tons on board. The cables are coiled in circular iron tanks, the largest of which holds 450 knots. The cable, which after severe testing has been passed by the Post Office authorities, is kept under water the whole time. All the latest machinery for paying out and testing the cable has been fitted up on board, but in the main the arrangements for picking up and paying out are the same as those adopted by Mr. Henley for the Persian Gulf cable in 1863. The rate of paying out will be at least seven knots. The vessel starts to-day, and proceeds to Bermuda to take some deep-sea soundings on the intended line of the cable. She will lay the shore end from Halifax, and will then proceed to pay out all the deep-sea portion. It is believed that the greatest depth will not exceed 3,000 fathoms. In the event of accident, arrangements exist for recovering the cable at that depth and picking it up again. According to present expectation the laying of the cable will be completed by the end of June. Altogether 874 knots of cable, weighing upwards of 2,000 tons, have been made, but the length to be laid will probably not exceed 830 knots. Mr. R. E. Peake, of Messrs. Clark, Forde and Taylor, represents the Halifax and Bermudas Cable Company. Messrs. W. T. Henley's Telegraph Works Company, Limited, are just proceeding with the manufacture of another submarine telegraph cable, nearly 1,000 miles in length.

British Association.—The following provisional arrangements have been made for the sixtieth meeting of the British Association to be held in Leeds during September next. On Monday, the 1st of September, the reception-room will be opened in the Victoria Hall, to issue tickets and give information. On Tuesday most of the officers of the association will arrive. On Wednesday, at 8 o'clock, the retiring president, Prof. W. H. Flower, C.B., F.R.S., director of the Natural History Department of the British Museum, will resign the chair in favour of Sir Frederick Augustus Abel, C.B., F.R.S., chemist to the War Department, who will deliver the inaugural address. The succeeding evenings will be occupied thus: On Thursday, at 8 o'clock, a *soirée*; on Friday, at 8.30, a lecture; on Saturday, a lecture to the operative classes (members of the association not admitted), by John Perry, F.R.S., Professor of Engineering and Applied Mathematics in the Technical College, Finsbury; on Monday, at 8.30, a lecture; and on Tuesday, at 8, a *soirée*. The lectures will be given by C. V. Boys, F.R.S., and E. B. Poulton, M.A., F.R.S. The sections will sit daily under their respective presidents from 11 until about 4, except on Saturday, when they will rise at one, and at these sessions papers in the following branches of science will be considered: A.—Mathematical and physical science: J. W. L. Glaisher, D.Sc., F.R.S., president. B.—Chemical science: Professor T. E. Thorpe, F.R.S., president. C.—Geology: Prof. A. H. Green, M.A., F.R.S., president. D.—Biology: Prof. A. Milnes Marshall, M.A., F.R.S., president. E.—Geography: Lieut.-Col. Sir R. Lambert Playfair, K.C.M.G., president. F.—Economic Science and Statistics: Prof. Alfred Marshall, M.A., president. G.—Mechanical Science: Capt. A. Noble, C.B., F.R.S., president. H.—Anthropology: John Evans, D.C.L., Treas.R.S., president. The Mayor and Corporation of Leeds have kindly granted the use of the Town Hall, and other bodies have placed at the disposal of the association various other buildings required for the purposes of the meeting. Considerable expense, however, must be incurred in fitting up these rooms and providing adequate attendance. The total cost will probably be about £3,000; to meet which donations amounting to £73, and promises amounting to £6,300 towards the expenses and guarantee fund have been already received. It is proposed to increase the fund to £8,000, that the burden may fail more lightly on each individual contributor. Donations or guarantees will be received by the treasurer, Mr. E. B. Faber, at the Leeds Old Bank.

Use of Motors.—A list of installations of C. & C. motors in America has lately been issued, and is interesting reading, showing the extended use made of electric motors: Edison Electric Illuminating Company, Brooklyn, one 3 h.p. for ventilating station and one $\frac{1}{2}$ h.p. fan outfit; one 1 h.p. to Pennsylvania R. R. shops, Altoona; one 10 h.p. to American Press Association, Chicago; one 1 h.p. to Messrs. Gahl and Lembke, Union-square, N.Y.; one 2 h.p. to T. H. Porter to run elevator; one 2 h.p. to Edison Electric Illuminating Company, Newport; one 10 h.p. to Sunday *Telegram*, Harrisburg, Pa.; one 1 h.p. to First Presbyterian Church, Easton, Pa.; one 1 h.p. to run ventilating fan; one 3 h.p. to Edison Electric Illuminating Co., Fifth-ave., N.Y.; one 8 h.p. to the Solomon Lord building, Eighteenth-street and Broadway, running elevator; one 1 h.p. to "Thompsons," New York, running ventilating fan; one 1 h.p. in Boston, to run coffee-grinding machine; one 2 h.p. to St. Thomas Church, Fifty-third-street and Broadway, New York, to run ventilating fans; one 1 h.p. to Edison Electric Illuminating Company, Fall River, Mass.; one 1 h.p. to Champion Card and Paper Company; one 5 h.p. to Fletcher, Portland, to run elevator; one 5 h.p. to Dr. Kilbourne, president of Seattle Electric Railway and Power Company, Seattle, Wash.; one 2 h.p. to Ryan Bros., Appleton, Wis.; one 1 h.p. to *Court Journal* Publishing Company, Washington, to run press; one 2 h.p. in Lawrence, Mass., to run lathe; one 5 h.p. in Wilmington, to run elevator; one 4 h.p. to Bradley Fertiliser Company, N. Weymouth, Mass.; one 4 h.p. Boston, to run ventilating blower; one 2 h.p. to Howard and Co., Fifth-avenue, to run jewellers' lathe and polishers; one 1 h.p. to Trinity Church, Easton, Pa.; one 3 h.p. to Whiting Manufacturing Company, Union-square, New York, to run jewellers' lathe and polishers; one 4 h.p. motor to Prof. C. A. Young, Halsted Observatory, Princetown, N.J., to turn observatory dome; one 5 h.p. to Fraser and Chalmers, Salt Lake City, Utah, to run a dynamo; one 2 h.p. motor to Kobe, Japan; one 5 h.p. motor to G. B. Grant, Boston; one 15 h.p. to Snyder and Black, 92, William-street, New York, to run lithographic and printing presses; one 1 h.p. to Wickstead Umbrella Company, running machine shop; one 1 h.p. to Church of Holy Communion, New York; one 3 h.p. and one 10 h.p. to Sanderson, Water-street, New York, running printing presses; one 10 h.p. to Trask Milling Machine Company, Boston, running machine shop; one 1 h.p. to print the Roanoke *Daily Herald*; one 1 h.p. to St. John's Church, Reading, Pa.; one 15 h.p. to the Wire Buckle Suspender Company, Williamsport, to run shop; one 15 h.p. to Wilmington, and another to Queen City Electric Light Company, Gadsden, Ala.; one 4 h.p. to D. Coughlin, Lawrence, Mass., to run 28in. saw; one 1 h.p. motor to Trinity Episcopal Church, W. Fourth-street, Williamsport, Pa., to run organ bellows; one 7 h.p. motor to Mercantile Printing Company, Wilmington, to run presses; one 20 h.p. to Perry and Woodworth, Cincinnati. A curious point in the above list is the number of churches that employ electric motors. The widespread character of the work reflects credit on the energy of the company and the construction of the motors.

Southend Electric Tramway.—A prolonged discussion was held by the Southend Local Board on May 13, when the question of the establishment of electric tramcars and lighting on the new pier was brought forward. It may be mentioned that the pier was designed by Sir James Brunlees for electric traction, and an estimate had already been received by the Board from Messrs. Crompton. The amount was £4,600, without extras or engineer's commissions, and the sum of £8,000 had been mentioned as the probable total cost. At the opening of the meeting Mr. Watson Smith, as a ratepayer and resident, protested, from knowledge he had of the specification, that the estimate of cost was "outrageously high," at any rate, very high indeed. He was a representative of Messrs. E. P. Elieson and Smith, though he spoke as a ratepayer, and had considerable experience on the North Metropolitan experimental line. The present line presented no difficulties of gradient, curves, and dirt, such as there encountered and could be done more cheaply than on ordinary roads He would guarantee to obtain a tender considerably below that mentioned, or to work it on yearly contract at so much per mile, and they would guarantee to have it at work within 28 days. The chairman thanked Mr. Watson Smith, and said the Parliamentary Committee would have been glad of his information earlier. The clerk read Dr. Hopkinson's report on Messrs. Crompton's amended tender, and stated Mr. Albright was present. The chairman recommended caution, not to bind the Corporation to any firm. If they accepted the tender before them it would mean an annual charge of £900, as against £325 with steam traction and gas lighting. He estimated the electrical work with commission at £5,500, or an annual cost of £550; the cost of working, with engineer's salary, £282, regulation of traffic £32, and allowance for extras of £36, made £900. Gas lighting would cost £57 a year, and the fittings on an elaborate scale could be done for £400; purchase and fixing of rails and engine could be done for £1,500. The comparative cost would be, he thought, £300, against a minimum of £800. Mr. Dowsett maintained it could be done for £400, electrically—interest £200, and cost of working, £12. 10s. six days a week. Mr. Ingram reminded the meeting that the pier was specially constructed for electric traction, and they could not alter without consulting Sir James Brunlees. He proposed a resolution that electricity be used for both lighting and driving on the pier. An amendment was proposed that a steam-engine be hired or purchased and rails laid down, but this was disallowed as identical with one negatived at the last meeting. A further amendment that the matter be adjourned was not carried. Mr. Ingram's motion that electricity be adopted was then carried by a majority of one. The motion that a specification be obtained from Dr. Hopkinson for the tram rails and steps be taken to procure such rails (about 90 tons) at once was carried. An interview was then had with Mr. Albright, who said it would take two months to get ready; the weight of the apparatus would be about $1\frac{1}{2}$ tons. After Mr. Albright had withdrawn, Mr. Watson Smith said, with his scheme $1\frac{1}{2}$ tons would be quite sufficient: he would have the affair at work within 28 days after the contract was signed. Mr. Smith was asked to put his particulars in writing, and hand them to Dr. Hopkinson to report upon. The suggestion that the matter should be put to public tender was negatived, and it was decided to allow Mr. Smith, or any
chose to submit a scheme up to last Tu

THE EDINBURGH EXHIBITION.—III.

The lighting of the exhibition buildings and grounds has been entrusted to two firms, the Brush Company and Messrs. King, Brown, and Co. The former have a contract for the whole of the arc lighting, and the latter for the whole of the incandescent lighting, except some stalls and some outside places of entertainment, which are lighted by some exhibitors gratuitously, by way of advertisement, we presume. These will be referred to later on.

The Brush Company have in all 15 dynamos. Six of them are driven by engine No. 1, and six of them by engine No. 2, described in last week's article. Each of these dynamos has a potential of about 2,000 volts, and generates a current of 10 amperes. There are 11 separate circuits, and on each circuit there are 35 arc lights in series taking 10 amperes at 50 volts, and giving a light equivalent to 2,000 c.p. Inside the buildings there are 288, arranged so that each of three adjacent lamps is on a different circuit. The grounds are illuminated by 82 arc lamps similar to those inside the buildings; 45 of them are in groups of three on 15 iron masts 65ft. high, 27 of them on nine iron masts 80ft. high, and the remainder singly on masts 25ft. high. Each mast contains within itself the leads for the lamps, also gearing for raising and lowering the lamps. Here also the lamps are arranged so that alternate lamps are supplied by different dynamos.

Each of the remaining three dynamos is driven respectively by Nos. 3, 4, 5 engines, already described. One of them has 25 arc lights on it, and has a potential of 800 volts. The other two dynamos are held in reserve. The switchboard is so arranged that any dynamo can easily and quickly be coupled on to any circuit. We could see no voltmeter on any circuit, so that the potentials given above can only be very rough approximations. There is an ammeter on each circuit—a type made by the Brush Company themselves. They were, however, placed on a board fully 7ft. high; hence, to read them, you would require to have *steps* or a ladder. It struck us as very odd to have them so placed that you could not see what they were indicating.

Messrs. King, Brown, and Co. have four dynamos driven by the two Westinghouse engines already referred to. They light the Concert Hall, the reception-room, and two of the refreshment-rooms. In all they have 110 incandescent lamps of the "Sunbeam" type, each of 200 c.p.

The bandstand is lighted by 116 lamps of 8 c.p., and 10 lamps of 100 c.p., from a dynamo of Woodhouse and Rawson. This dynamo is situated in the Dynamo Court, driven by Robey engine No. 1, and has a potential of 100 volts.

The panorama is lighted by Thomson-Houston arc lamps, current being supplied by a Thomson-Houston arc dynamo. These lamps, we understand, were fitted up by Richard Miller, of Glasgow.

The Venetian glass house, the fish dining-rooms, and the swimming pond are lighted by Messrs. Ernest Scott and Co. An alternating machine of 1,000 volts, reduced to 100 volts by a transformer, is used.

Several exhibitors light their own stalls. These will be alluded to later on.

The makers of dynamos are well represented, though a good number of them have not their exhibits forward yet. Meantime we need only mention a few of them, reserving further details. The India Rubber Company, Silvertown (65), send a large dynamo, designed to run at comparatively low speeds, and to give 350 amperes at 100 volts. Messrs. Latimer Clark, Muirhead, and Co. have a search-light projector on the roof of the Machinery Hall, in which is a Westminster automatic focussing arc lamp of 20,000 c.p. The current is supplied by a "Westminster" dynamo, giving 80 volts and 100 amperes. Messrs. Rankin Kennedy and Co. (71) send a most varied and interesting exhibit, including their recent alternating motor. Details of this motor will be given in a few weeks. Messrs. Norman and Son (29) show dynamos and engines for ship, factory, and private house lighting. The Woodside Electric Company (60) show dynamos for incandescent lighting, for arc lighting, and for electroplating. Messrs. Ernest Scott and Co. (62) show dynamos professing to be of great mechanical strength. Messrs. Priestman and Bros. (59A) show how a domestic installation may be set up with an oil engine. The Electric Construction Corporation show, among other varied exhibits, a 100-unit alternating dynamo and engine combined.

The makers of electrical measuring instruments are not so numerously represented. The pre-eminence must be given to Mr. James White, of Glasgow (83), who shows in a neat case at end of Machinery Hall a few of Sir William Thomson's beautiful and accurate instruments. We understand the standard balances are guaranteed to be accurate to within $\frac{1}{10}$th per cent. We shall, in a future article, describe these instruments briefly, as we believe they are by far the most reliable in the market. Mr. James Pitkin (108) shows electrical chronographs, reflecting galvanometers and other electrical measuring instruments. Prof. Blyth (410) shows various forms of current meters and voltmeters.

The Post Office exhibit is a most instructive one: instructive to all, for to each piece of apparatus is attached a label briefly describing it. In this article we need only mention a few of them. Cooke and Wheatstone's earliest needle telegraph, 1837; specimens of first telegraph line, 1837; Cooke and Wheatstone's four-needle telegraph, 1838; Cooke and Wheatstone's double-needle telegraph, 1844; Henley's magneto double needle, Bain's chemical telegraph, 1850; Morse embosser, Wheatstone's type-writing instrument, Hughes's type-printing instrument, Preece's electrical semaphore, 1860. The foregoing are only of historical importance. In the same exhibit are the modern telegraphic apparatus, consisting, among other instruments, of—printing telegraph apparatus, showing Wheatstone automatic transmitter, receiver and perforators, local inker, sounder, key, galvanometer, rheostat, and switches; Bright's bell; Wheatstone alphabetic instruments; lightning-protectors for cable and land lines; fast speed repeater; Delaney multiplex distributor; and Willmot's double-sluice pneumatic valve.

Beside the Post Office exhibit is a case by the managers of the Watt Monument, Greenock. "In this case is displayed a copy of the *Scot's Magazine*, in which appeared the letter, dated Renfrew, February 1, 1753, entitled 'An Expeditious Method of Conveying Intelligence,' and signed with the initials 'C. M.' To Sir David Brewster belongs the sole credit of having rescued from oblivion 'this remarkable document,' as he called it; of having zealously investigated as to its authorship; and of establishing the fact that the writer was a 'gentleman in Renfrew of the name of Charles Morrison, who transmitted messages along wires by means of electricity, and who was a native of Greenock, and bred a surgeon.'

"In the case are also shown the original letters received by Sir David Brewster, revealing all the little that is known about Morrison, and which reached their present destination through the kindness of Lady Brewster, and Sir David's representative, Mr. C. Brewster Macpherson, of Belville House, Kingussie. The telegram affixed to the copy of the *Scot's Magazine*, shown in the case, was the outcome of a day's visit to Renfrew connected with this matter, and in it the fact of Charles Morrison's being its inventor was carried away from that place, and necessarily from near the spot where he pursued his experiments, by that expeditious method of conveying intelligence, which he was the first to suggest."

THE CHARACTERISTIC AND ARMATURE WINDING OF THE FOUR-POLE HELVETIA DYNAMO.

BY E. GUINAND.

At the beginning of 1889 some improvements were introduced in the Helvetia dynamo, made by R. Alioth and Co., of Basle. In the well-known 1884 type of the old four-pole machine, Fig. 1, the magnets were placed spherically, and the armature was of a peculiar cylindrical form, but at the time mentioned the dynamo was altered, in so far that the winding of the magnets was made more simple, and a better arrangement of the iron masses was adopted. In the new type of machine, as shown in section in Fig. 2, the four poles are made wider at their outer than at their inner ends. This method has been adopted in order to shorten the path of the lines of force in the magnetic field, and the employment of the four poles also diminishes the magnetic resistance in the armature. The old form of machine had the coils wound round the framework or yokes and round the pole-pieces, but in the new type the latter only are wound. The round or spherical shape of the electromagnets has been retained because it protects both the magnet coils and the armature, and also gives to the machine a pleasing appearance. Moreover, perforated plates are arranged on the open sides, thus facilitating ventilation. The brush holder is supported by a cast-iron ring, which can be turned by means of a small toothed wheel or screws in order to place the brushes in a non-sparking position.

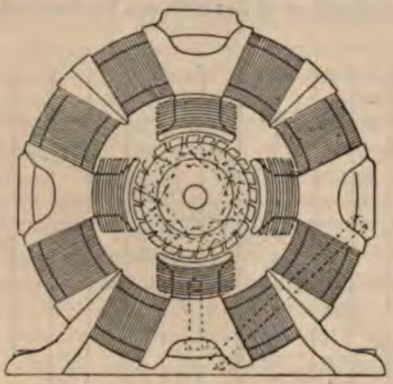


FIG. 1.

The principal feature of the dynamo is the armature, Fig. 3, which has a ring-shaped core, upon which the coils are simply laid. The armature winding consists of wire frames, Fig. 4, which are previously made according to a certain design. In the old form of incandescent light dynamo the frames were made of copper bars, but in the new type they are formed of copper wire, in order partly to avoid eddy currents. At the same time it must be remarked that wires of the same layer (which thus belong to the same frame) which lay upon one another are never arranged in parallel. These four-pole dynamos have only two brushes (placed at an angle of 90deg and formed of several equal brushes made up of copper wire), and the wire frames are therefore arranged on the commutator either in parallel or in series, as may be desired. These methods are represented in Figs. 5 and 6.

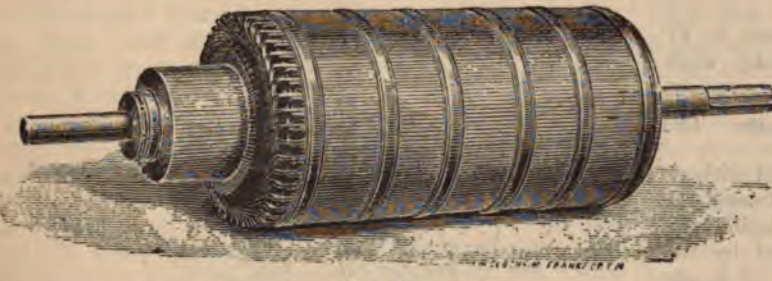


FIG. 3.

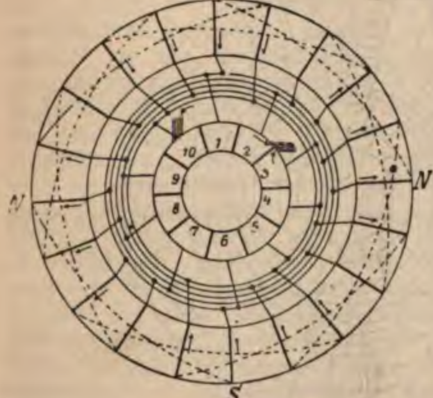


FIG. 5.

The method of winding the large six-pole dynamos of from 100 h.p. upwards is analogous to that shown in Figs. 5 and 6 for low tension; but for high tension the winding is arranged on the Breguet principle. The small dynamos also have four poles, in order to retain the uniform construction of the armature; but only two of the poles are wound with wire. In this case the form of the dynamo is similar to that of an ellipsoid, and the field-magnets are made of cast-iron. For certain purposes, such as for ships, tramways, etc., the dynamo is made only of wrought iron, and for the latter purpose the magnets would be, as far as possible, placed very low.

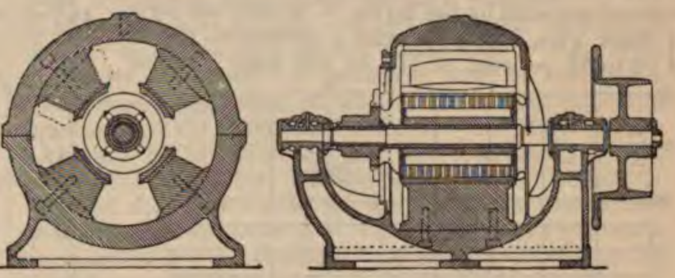


FIG. 2.

The iron core of the armature consists of groups of iron rings insulated by paper, the groups being separated from each other by air space. The wire coils on the armature do not touch each other. An air space of from 1 mm. to 1·2 mm. is allowed between each set so that the hollow cylinder is well ventilated. Consequently, the current density of the armature winding can attain six amperes for one square millimetre without causing excessive heating. The usual current density is, however, from four to five amperes. The dynamo works without noise and sparking. As the wire coils are only brought over the surface of the hollow cylinder, the total lines of force, as in a drum armature, pass through the surface of the coils, which action does not occur with the usual Gramme ring. Thus, in the first case, the E.M.F. obtained is, for the same weight of copper, double that in a ring armature. The employment of four poles, which lessen the path of the lines of force in the armature, does not permit of much iron being used in the core, but the magnetising effect is comparable to that with a drum core of a two-

(Less iron is, therefore, used in a

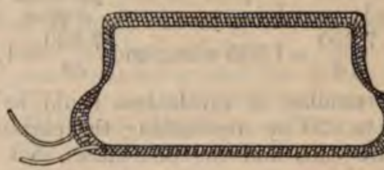


FIG. 4.

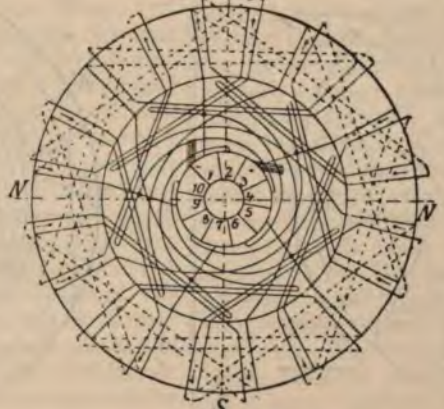


FIG. 6.

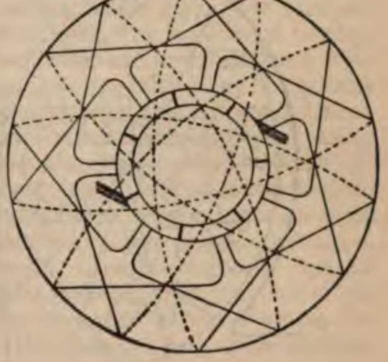


FIG. 9.

Fig. 7 represents the connection between the E.M.F. (on open circuit) and the exciting current, and Fig. 8 is the characteristic curve. Referring to the curves for one of the magnetic circuits: A refers to the iron core, P and M to the cast-iron pole-pieces of the frame, L is the air curve and C the characteristic; c_1 and c_2 are the curves obtained in trials. At the beginning the characteristic curve, C, runs in a straight line, and commences to curve with the total induction, 2×10^6, of the magnetic circuit. The dynamo is over-compounded by the laying on of only one layer of thick wire. It works with a saturation degree of 50 to 55 per cent. at 110 to 120 volts terminal pressure at a linear speed of 11 metres (950 revolutions). The electrical useful effect at full output reaches 88·5 per cent. and the commercial efficiency 84 per cent.

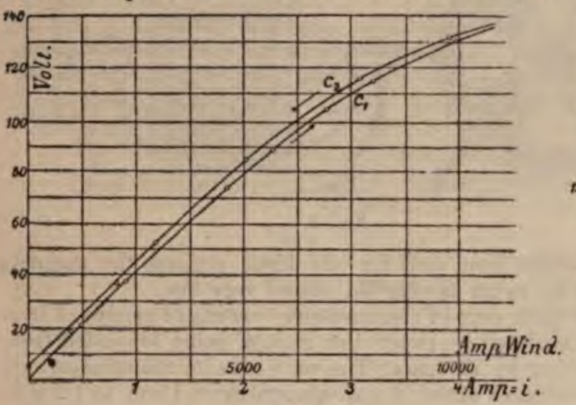


FIG. 7.

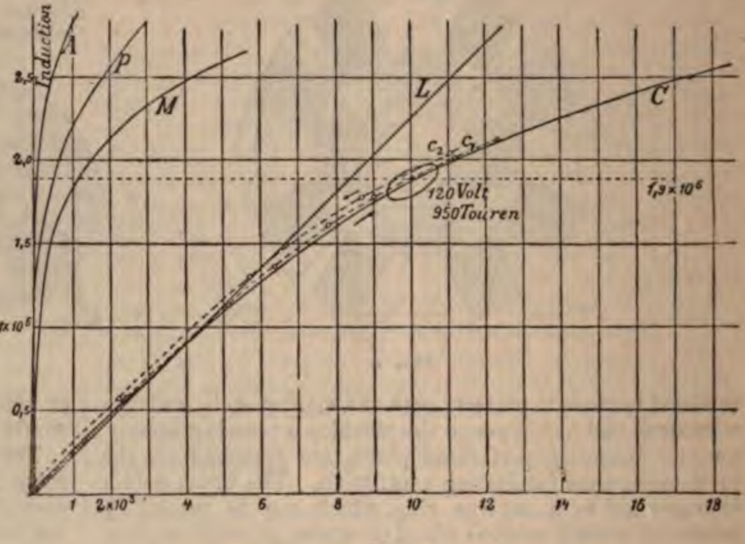


FIG. 8.

The weight of the armature wire amounts to only 5·5 kilos (about 12lb.), and that of the electromagnets to 67 kilos (about 147½lb.). Consequently, the useful work obtained per kilogramme of copper of the various wires $\frac{7,200}{5 \cdot 5} = 1,300$ watts, and $\frac{7,200}{67} = 1,075$ watts. The normal number of revolutions could be reduced without danger to 850 by diminishing the clearance between the armature coils and the pole-pieces, but considering the large working safety and great solidity obtained by the strengthening of the armature coils by means of strong ribbons, the makers prefer to give the armature sufficient play. Those machines which give more than 15 kilowatts yield 90 to 93·5 electrical, and 85 to 89 commercial efficiency.

In the following are given a few remarks concerning various methods of winding. From observations made with the very small dynamos, it has been found that half the number of commutator laminæ should be an uneven quantity, so that the width of the coils comprises an angle of 90deg. on the armature, in order to avoid the production of sparks; but the winding is seldom symmetrical, as shown in Figs. 5 and 6. Only one of the two brushes momentarily short-circuits two coils, or two groups of coils.

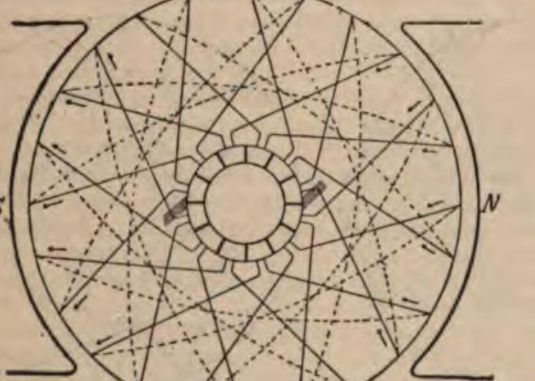


FIG. 10.

In the Edison winding, Fig. 9, the drum armature of the two-pole dynamos has an uneven number of commutator segments. Thus, simultaneously in this case only one armature coil is short-circuited by one of the brushes at the moment of passing the neutral zone. An equal number of laminæ is arranged in the Frölich winding, Fig. 10, and also in the modified Breguet method, Fig. 11. Consequently, at the same time two divisions of the coils can be short-circuited, and with the first coils, which lay immediately near one another, and between which the full pressure exists. In the Breguet method of winding, Fig. 11, this disadvantage is overcome, but in this case the angle between the pole tops must be made sufficiently great, and the surface-winding much larger than the cross-section of the pole-piece. This method of winding can be used equally as well as others in multipolar dynamos, Fig. 12, and will, perhaps, not be regarded as a novelty. It has been practically employed in many cases for a long time past, and gives good results, especially in the transmission of energy by two and more pole dynamos with drum and ring armatures.—Translated from the *Elektrotechnische Zeitschrift.*

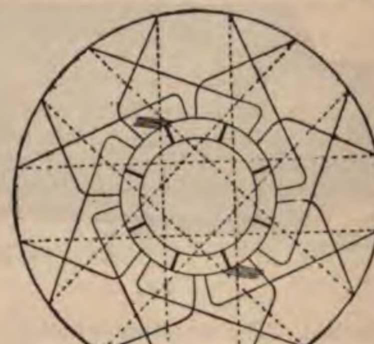


FIG. 11.

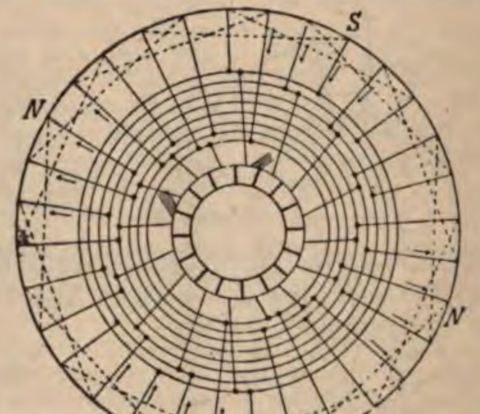


FIG. 12.

THE KESWICK WATER POWER ELECTRIC LIGHT STATION.*

BY W. P. JAMES FAWCUS AND EDW. W. COWAN, A.MM.I.C.E.

This was believed to be the first attempt to utilise available water power in this country for the purposes of a public supply of electric light. Early in last year the directors of the Keswick Electric Light Company instructed the authors to prepare plans and to procure tenders for the erection of a central supply station in or near Keswick. As the area proposed to be lighted was large and sparsely populated, it was seen that the only feasible system to adopt was an overhead high-tension one. The alternating-current transformer system was finally selected, and a site on the River Gretna, about three-quarters of a mile from Keswick, was chosen for the erection of the station, the river being here available at 20ft. head. The saving effected in using this water power was considerable. The rent paid for the water was 10s. per horse-power per annum. Taking the number of horse-power hours required per annum as 100,000 for the present output of the station from a 50 h.p. turbine, the cost per horse-power came out as 0·06d. On the other hand, taking the price of steam coal at 15s. per ton, and the quantity burnt per horse-power per hour as 6lb., the cost per horse-power hour came to 0·48d., or eight times the cost of the water power. In addition to this, the attendance required for a turbine was, of course, less than that necessary for a steam engine and boiler; the first cost, maintenance, and depreciation were also considerably less, and the chances of a breakdown much less likely. As there was a possibility of partial failure of the water supply during extreme drought in summer, it was decided to provide steam in addition to water power. The turbine was of American design, and was called the "Victor." It was of a "mixed flow" type, the wheel being 20in. in diameter. Its speed was 273 revolutions per minute. This was at least 70 per cent. greater than the speed of an "inward," an "outward," or a "parallel-flow" turbine would have been, working under a similar head. Its design was exceedingly compact, and the regulation, which was effected by opening and closing a cylindrical sluice working between the guide passages and the wheel, was all that could be desired. As the turbine was 16ft. above the level of the tail race, a draught tube was necessary to give full effect to the head of 20ft. This draught tube was of wrought iron, 14ft. long and 3ft. in diameter. The maximum velocity of water flowing through it was a little over 4ft. per second. The engine was a Westinghouse of simple type, having two single-acting cylinders, 10in. in diameter and 9in. stroke; it gave with 80lb. of steam, at 350 revolutions per minute, 50·11 brake h.p. The floor space taken up by the engine was 7ft. by 4ft. The boiler was a 20 nominal h.p. Hyde duplex, 4ft. 6in. in diameter, and 11ft. 6in. in height. Its working pressure was 120lb. to the square inch. The alternator, which was designed by Mr. Gisbert Kapp, and manufactured by Messrs. Johnson and Phillips, the contractors for the electrical plant, was a 30-kilowatt separately-excited machine, giving an output of 15 amperes at 2,000 volts. Its speed was 750 revolutions per minute, and the frequency 75. The armature had a cast-iron supporting ring, 28in. in diameter and 2½in. wide, provided with six arms. The armature core was of charcoal-iron strip, 2½in. wide, wound with paper insulation to a depth of 8in. There were 19 coils, each containing 100 turns of 0·072in. wire, covered to 0·092in. in two layers. The resistance of the armature, after working some hours, was found to be 7 ohms. The magnetic field consisted of 12 magnets on each side of the armature. The cores and pole-pieces were of wrought iron, the yoke-rings of cast iron. The former were cylindrical, 3¾in. in diameter. The latter were 4in. by 7¼in. Each core was wound with six layers of 58 turns per layer, with 0·102in. wire covered to 0·117in. The total resistance of the field after working some hours was 11·2 ohms. At full load the energy of the field was 3 per cent. of the output of the machine. The framework was of substantial construction, and the machine when running was remarkably free from vibration. Its open design admitted of the free passage of air to the armature, which would carry 20 amperes without overheating. The magnets could be racked aside for access to the armature. The exciting dynamo was a 1-kilowatt machine of the Gramme type, giving 10 amperes at 100 volts. Regulation was effected by varying by hand the resistance in the field-magnet circuit. Two circuits left the station, both of which were double-pole fused, and provided with double-pole switches and lightning arresters. There were some special features in the method of carrying out the overhead mains. If wire of high insulation had been used the expenditure would have been considerable, and it did not appear that any great advantage, other than increased durability of the mains, would have resulted. It was therefore determined to use a lower insulation for the mains, and to rely upon the points of support for insulation, also to use special arrangements for cutting off all surface leakage where the wires entered the consumer's premises. The authors were not aware that attention had been paid to this point before, yet it would seem that in wet weather, upon a long line of overhead mains, even with the best insulation, the surface leakage, when high-tension currents were employed, would be considerable; and if devices were not adopted for cutting this off where the wires entered buildings, leakage to earth must result, which might be a source of danger as well as of loss. The mains at Keswick were being insulated from earth, and from each other, by oil throughout the system. The house leading-in wires were insulated with vulcanised india-rubber of the highest quality, and were threaded through a shackle oil-insulator, the wire being cemented in with Chatterton's compound. Such an arrangement should effectually cut off surface leakage from the mains. The leading-in wires entered the roof through a stoneware pipe, provided with a covering piece to keep out rain and cover a reservoir of oil in the mouth of the pipe. The sizes of the mains were fixed for a current density of 500 amperes to the square inch. The fall of potential between the generating station and the town, was only slightly above 1 per cent. at full load. Steel suspension strand was used for supporting the mains for all circuits, consisting of three strands, each strand being 14 B.W.G., and galvanised. One short run of underground mains was being tried, the Brooks fluid system being used. This system had much to recommend it. It was simple, cheap, and durable, and did not take long to lay down. The transformers were Kapp's patent, and they transformed the high-tension current of 2,000 volts to 100 volts. A double-pole, quick-make, and quick-break switch, with double-pole fuse and lightning arrester, was used in the high-tension circuit with each transformer. Both the transformers and the switches were enclosed in cast-iron water-tight cases. A series of experiments had been made to test the efficiency of the machinery, with the result that the total efficiency of the generating plant at the station came out at about 40 per cent. at ¼ full load, and over 70 per cent. at full load. In connection with the arrangement of this central station scheme the authors had occasion to make a comparison between the illuminating power of the glow lamp and gas; the results showed that the relative values usually given were misleading, as they almost invariably dealt with a standard London argand, a burner seldom used for ordinary lighting. This burner was generally taken as giving from 15 to 16 c.p. for 5 cubic feet of gas consumed per hour; whereas out of a large number of ordinary burners taken haphazard, and tested where they were in use, in Chester, Manchester, and Keswick, at various times, it was found that the light given by 5 cubic feet of gas per hour was more frequently equal to eight candles or less. This would show that, in practice, one 16 c.p. glow lamp gave approximately the same degree of light as two ordinary burners, each consuming five cubic feet of gas per hour. This conclusion seemed to be borne out by the result obtained by Dr. Hopkinson, who, experimenting upon some ordinary burners, found the average candle-power to be 1·76 per cubic foot of gas. As regarded glow lamps, Sir David Salomons found that the 100-volt 16-c.p. Edison-Swan lamps averaged 17 c.p. at 100 volts. The light had been received with great favour at Keswick, and already the demand was equal to the supply of the present plant. Supply was commenced at the beginning of the year, and the station had run without hitch up to the present time—a man and a boy being found sufficient for tending the machinery.

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* Abstract of paper read before the Institution of Civil Engineers.

THE

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Specimen copies of the paper will be sent on request.

GOOD FOR THE LAWYERS.

The electrical industry has been a prolific source of occupation for the legal profession, and every month seems to raise up some subject that has to be fought out in the courts. The latest rumours point out litigation in connection with accidents causing damage by fire. It is impossible for laymen to attempt the technicalities of legal phraseology, so that anything lacking in this direction must be supplied by the lawyers. Accidental fires have arisen through electrical causes, and the insurance companies have paid losses caused by such fires. In some cases the fires have been directly caused by bad workmanship, and we are informed that the fire insurance companies that have to pay such losses can take legal action and recover sums so paid from the companies or contractors that put up this bad work. It is rumoured that an action of this kind is now pending, and as similar actions may follow it would be unwise to consider any specific case. Fires caused by the leakage of gas have similarly led to litigation, and the insurance companies have been successful in their operations. Of course the gas journals are not likely to make any great fuss over cases of this kind, though they will doubtlessly try to make profit out of failures electrically. The lesson which electrical engineers have to take to heart is that they can be, and they will be, held directly responsible for mistakes and carelessness in wiring. If the legal position we have indicated is the correct one it cannot be too widely known, and it will prove pretty effective in putting a stop to some of the insane competition to get work at low prices. A very large number of installations are carried out in accordance with the fire insurance rules, and under the supervision of the engineers of the companies. Where this is the case, even if a fire occurs, we presume the insurance companies have no remedy. Their demands have been complied with and they take the risk. One point, however, is obscure and will probably remain so till cleared up in the courts. Let us suppose an installation carried out in accordance with the regulations now in force, and that ten years hence a fire occurs. It may be that what is thought sufficient now will not be thought sufficient ten years hence, in other words, what may be considered bad workmanship ten years hence is not so considered now, and it will be an exceedingly tough nut for the legal fraternity to determine what really constitutes bad workmanship. We know of an installation, condemned as regards certain wiring some three or four years after first put up, about which the engineer very pertinently asked the doctors called in to report, whether in their opinion the work was not carried out in the best possible manner considering the experience and knowledge of the subject when carried out. The reply gladdened the engineer's heart, for it was what he wanted and what he expected, that the work was fully abreast of what was expected at the time it was executed. Putting aside doubtful cases, there are, however, a considerable number of houses wired in such a manner as would be condemned by any engineer of the slightest experience. It is these installations that usually break down; that if they cause no fire, continually give trouble and often have to be replaced. A few examples in the law courts, where not only the damages but the legal expenses will have to be paid out of the contractor's pocket, may have the effect moral suasion fails to obtain. The first of these actions, if fought out, will have great interest for the profession, and will lead to a very general overhauling of work carried out. Probably another outcome of such action will be to give rise to a new class of men, who may be termed examiners, whose duty will be to periodically inspect all the wires of a company's system. A railway ganger is continually on the look out for indications of wear and tear upon his section of the lines, and prevents rather than cures dangers, so the examiner or inspector should prevent rather than cure electrical faults. When it is understood that getting the work through and taking the money does not end the responsibility, there will be less and less tendency to attempt work at low prices with the intention of shirking the due performance of the work. Instead, therefore, of being an evil, a little litigation of the kind indicated may prove a blessing in disguise.

CORRESPONDENCE.

ELECTRICAL TRAMWAY SYSTEMS.

To the Editor of The Electrical Engineer.

Sir,—We have read Mr. Allsop's letter in your last issue, and have obtained copies of the specifications to which he refers.

We observe that Mr. Allsop finds it difficult to see any new points in our system, and we are not surprised at this, if, as would appear from his letter, and indeed from his specification, Mr. Allsop attaches no importance to mechanical details, which he thinks may be entrusted to any mechanic.

In our opinion and, we would venture to say, in the opinion of engineers at large, a successful invention is not so much dependent on a happy idea as on the careful consideration and working out of the many details essential to enable such an idea to be put into a practical working form.

It is to these essential details that we have devoted our attention, and, notwithstanding Mr. Allsop's opinion to the contrary, we still think that our system is very far from being identical with that which he proposes.

It is unnecessary to enter into a lengthy controversy in your columns in regard to the differences between Mr. Allsop's system and our own, and so far as your readers are concerned, their interest will naturally be confined to an examination of the practical merits of the system, and the relative merits of our respective claims can have no bearing on this side of the subject.—Yours, etc.,

J. Edward Waller.
E. Manville.

Princes-mansions, 68, Victoria-street, Westminster,
London, S.W., 20th May, 1890.

LIGHTNING-GUARDS FOR TELEGRAPHIC PURPOSES.*

BY DR. OLIVER LODGE, F.R.S., MEMBER.

(Continued from page 394.)

I have now to report that Dr. Alex. Muirhead has kindly made me an actual and highly-finished instrument on this plan, designing it himself. This instrument I have here (Fig. 10), and I have also received from him to-day this round and more compact and, I suppose, cheaper form of the same instrument (Fig. 11); with one-half the coils omitted, according to a plan of mine which, though not in all respects so theoretically satisfactory, may answer well enough for many purposes—as I shall mention further on.

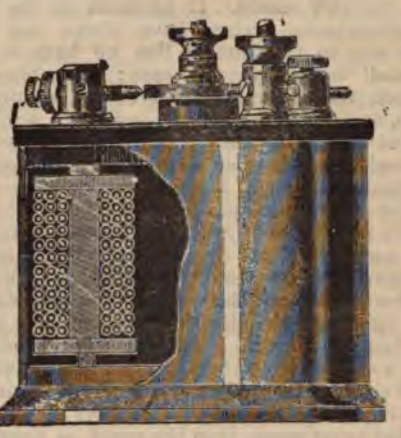

Fig. 10.

I now insert the first-mentioned protector in the path from Leyden jars to galvanometer, and I show that with all-sized flashes, from the smallest to the biggest here practicable, the galvanometer is protected; its needle does not move, neither does its safety valve sparkle. Examining it still more strictly and rigorously, I find that the insulation protection is indeed quite perfect, but a faint trace of a wave does pass round the galvanometer wire and affects the needle slightly when in a sensitive condition. To see this clearly, one must allow the needle to recover from the disturbance due to the charging current before permitting the discharge. The galvanometer shows easily the charging current from a common frictional plate machine; in fact, the spot of light moved several inches with such a current. Connecting it up through the protector, with a small single-pair-of-plates inductive machine charging the jars and giving pretty long sparks, the usual occurrences observed are as follows: between each spark, while the jars are charging, the spot of light deflects considerably, gradually less as the jars get fuller, until they discharge; when, instead of a kick back, as one might expect, there is rather a leap forward, by reason of the suddenly restored strength of the now almost unopposed charging current.

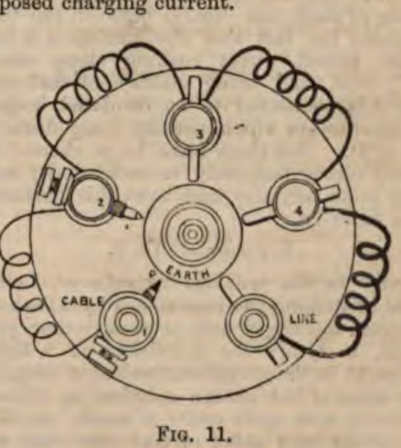

Fig. 11.

Whenever we thus want to see the charging current we must, of course, make fair metallic contact with the outsides of the jars, so as to close the circuit through the galvanometer; but, in order to further test the instrument, I make a break at one or both of its terminals, and allow flashes to strike either A or B, or both. It is not really a more severe test than the other—not quite so severe, in fact; but it looks worse, perhaps, and at any rate it is the simplest plan of keeping the charging current out of the galvanometer, and so securing that the needle shall be ready to indicate the slightest effect which the unfiltered-off portion of the discharge is able to produce. But there is practically no effect to be seen.

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* "On Lightning-Guards for Telegraphic Purposes, and on the Protection of Cables from Lightning, with Observations on the Effect of Conducting Enclosures." Paper read before the Institution of Electrical Engineers, April 24th, 1890.

You observe that my instrument is symmetrical—*i.e.*, that there are just the same coils in its earth-connected as in its insulated portion. It may easily be supposed that this doubling of the parts is unnecessary, or even deleterious. It may be plausibly argued that coils interposed in the earth connection are bad as well as useless, and that both the terminals on that side, B and D, should be agglomerated together: that, in fact, a preferable pattern would be that shown in Fig. 11, where there is only one earth terminal towards which all the others point. I think, indeed, that there are many cases where this will serve sufficiently well, but I do not regard it as so theoretically sound as the other, for this reason. It proceeds on the assumption that every disturbance arrives from above and is anxious to make its way to the earth. But we have no guarantee that such shall be always the case: disturbances are as likely to reach the apparatus from below, surging up from earth to line, and in that case the coils are wanted in the earthed half of the instrument. I return to this question later.

When I speak of a disturbance travelling from earth to sky instead of from sky to earth, I do not mean that in one case the sky is negative and in the other positive. Questions about sign of charge have nothing to do with it. There is some amount of unnecessary haze abroad on this matter. Think of a sudden electrical disturbance imparted to a thin isolated copper wire. It starts at some point, and flashes along the wire with precisely the speed of light, and the electric wave or pulse reaches the different portions of the wire in successive epochs of time.

Instead of a single wire, think of what must always exist—viz., a closed circuit; two pulses or waves originating at some point of this circuit flash round it both ways at a pace usually rather less, but never more, than the speed of light, and meet at the antipodes of the starting point. If the circuit is unclosed each pulse will get reflected and return, surging to and fro, perhaps, several times, and in such cases any point of the wire is reached by pulses travelling first one way and then the other—a phenomenon very characteristic of disruptive disturbances, but the first pulse is likely to be the strongest. It must be clear, I think, that for such alternating currents, as well as for rushes of uncertain direction, a symmetrical protector is best.

To illustrate these things, make a few more experiments with Saunders' protector, which I choose as one of the best; any other will do.

Experiment No. 8.

Connect a Saunders' protector to earth and to any line wire in the proper way, and attach a single wire to the "protected" terminal, like the wire, C G, in Fig. 3. Now send a discharge between line and earth either way, and the "protected" wire will be found ready to give off sparks at every flash. It will spark to anything—to the earth, to an insulated body, even to its own earth screw, B or D. Connect to it a galvanometer, or, better, a coil of wire one has no compunction in spoiling; then if the far end of the coil be attached to anything, either to the earth or to another line, or to an insulated body—even an insulated body of small size—sparks between the turns of wire will demonstrate the fact that the insulation is being broken down by the lateral waves rushing along the nominally "protected" wire, and being either reflected or absorbed according as it is connected to an insulated body or to the earth. The connection which permits least disturbance is to the screw B or D. But there must be no chance of the galvanometer being either purposely or accidentally connected to earth in some other way also, else even this partial protection has its virtue removed.

Experiment No. 9.

The "earth" in the previous experiment being the gas-pipes, instead of striking the instrument by a flash direct, let a flash be imparted to the gas main at some other point, say, in another room, to typify the possibility of a lightning flash striking the earth in the neighbourhood of a telegraph station. Immediately some of the charge splashes up from the earth, and the protected wire again emits a spark, or, if it be connected to anything by a scrap of fine wire that wire may be deflagrated. Thus we see that earth connection is not so utterly safe as might be supposed. Secondary surgings may rise up out of the ground and do damage to whatever is connected to it. I believe there are more instances of such occurrences than are usually recognised. But I prefer to leave the enumeration and discrimination of instances to persons of experience.

Experiment No. 10.

But now insert in the so-called protected wire an arrangement of air gaps and self-induction coils, after the fashion which constitutes my system of protection (Fig. 12). Then inserting a fine wire, or a coil, or a galvanometer, or any other detector, in the interval, and connecting the far end of the wire to anything as before, it will be found that although every trace of signalling current is able to affect the galvanometer, no appreciable trace of a violent disturbance is felt there; it is now securely protected whichever way the disturbance comes.

The electromagnetic inertia possessed by the coils protects it from sudden currents in the same manner as the inertia of a penny protects it from disturbance when it is balanced on a finger with a card under it, and the card smartly fillipped away.

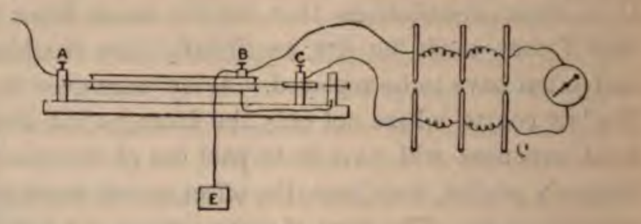


FIG. 12.

It is not, however, to be supposed that inertia alone, without successive air gaps, can exert this protective influence. The coil of a galvanometer has plenty of the required impedance, far more than the thick wire coils on my instrument, but the only effect of that is to shunt violent disturbances through the insulation—by no means a satisfactory property. The *combination* of air gaps or escape valves along with obstructive inertia is essential to the device. Let me here interpolate the remark that the self-induction of my coils is quite small; a very small amount of wire thus distributed suffices. Three or four yards of No. 16 wire are all I need use. I am well aware of the objection to introducing great self-induction in circuits where rapidity of signalling is desired.

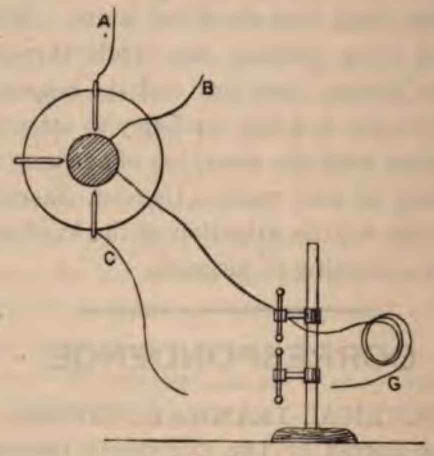
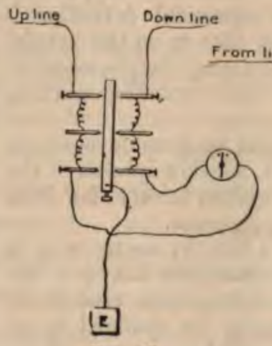


FIG. 12A.

With respect to the use of the one-sided pattern (Fig. 11), its effect will be represented in Fig. 10 if the right-hand set of coils are short-circuited out by a thick wire. In that case the galvanometer, though it is protected from disturbances arriving from the left, is exposed to those coming from the right.

This dichotomised pattern is therefore only permissible when there is a fair presumption, or complete certainty, against disturbances arriving this way. Cases of this sort will be mentioned in connection with the protection of cables.



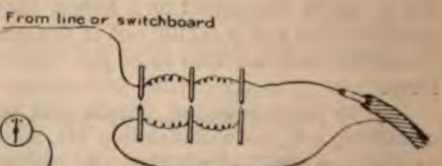


FIG. 13. FIG. 14.

The patterns so far drawn correspond rather to the sort suitable for a terminal station; but for an intermediate station where an "up" and "down" line wire meet, but where there is no necessary "earth," except an earth adapted to filter off lightning disturbances from the wire instead of passing them from station to station, the following pattern is suitable (Fig. 13). It explains itself; it is virtually the round pattern doubled.

SUBMARINE CABLES.

All that has been said applies by implication to the protection of cables, as much as to any other sort of covered wire out of which it is desired to keep violent rushes of potential, but about cables there are a few special things to be said which we will proceed to say now. Not only is a cable a tremendously valuable piece of property in which a slight fault costs a large sum to repair, and hence the utmost precaution ought to be taken in their case (even the instruments employed in signalling being so expensive as to deserve a thorough protection if it can be given), but the fact that cables are always coated with a stout metallic sheathing is a peculiar circumstance not found in the lines of land telegraphs, whether overhead or underground, and it is a circumstance which I wish to point out renders their complete protection from lightning peculiarly definite and easy.

First, it is clear that risk is run wherever a cable is connected to a land line. I do not suppose this is ever done with the long ocean cables, but for short lengths, across gulfs, etc., I suppose transmission is usually immediate. Even with ocean cables I understand that the land line to the station is often led to the same switchboard as the cable instruments are connected to, and whenever there is any sort of proximity of this kind a flash received by some distant part of the land line must be liable to spit across some of the terminals and flick off a bit of itself into the cable and its instruments.

Two lightning switches at least ought to be employed in every such station, one, a coarse one, at the place where the land line enters the building, to eliminate the grosser violence, and another, a fine one, at the mouth of the cable, to filter out the last traces of dangerous disturbance.

A proper mode of connecting one of my protectors to a cable is shown in Fig. 14. Here the outside sheath of the cable is used as sole earth, as is, I believe, customary. Another proper mode is to have a subsidiary or local earth, connection being made as in Fig. 15.

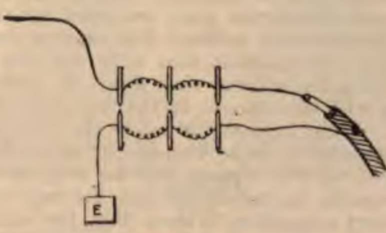


FIG. 15.

I am not prepared to support one of these in strong preference to the other. The second plan, however, is not to be adopted without the local earth. If there be no local earth, the first is the only proper plan, for it permits disturbances coming down the line to get to the outer sheath of the cable as directly as possible, the interior being protected by impedance; it also permits disturbances surging up the cable sheath, as they may when the shallow shore water is struck by a flash, to get to the line capacity directly, and not to easily enter the cable core.

But now suppose a case where no land line or connection is permitted to come within many yards of the cable station, though I suppose such a plan would be extremely inconvenient; let the cable be connected to nothing but its own instruments—where is the need of a lightning-switch then?

The only danger that can occur now is when these instruments are struck direct, either from the roof or walls, or from gaspipes, or from the earth upon which they stand. A filter must therefore be arranged to protect the cable, even in this case. No fragment of cable core exposed outside its sheath can be considered safe. It would only be quite safe if it could be wholly put inside its metallic sheath and kept there.

(*To be continued.*)

PROF. ELIHU THOMSON'S ELECTROMAGNETIC INDUCTION EXPERIMENTS.*

BY J. A. FLEMING, M.A., D.SC., M.I.E.E.

I. In the Paris Exhibition of 1889, and in the United States Court, many present will, perhaps, recollect to have seen a collection of electrical apparatus, contributed by Prof. Elihu Thomson as his private exhibit. These pieces of experimental apparatus constituted the appliances for illustrating some highly remarkable and interesting facts in electromagnetic induction. It is more than probable that very many persons interested in electrical discovery either did not find, or did not happen to see in action, these instruments, or perhaps had not the opportunity to see them at all. By the kindness of Prof. Elihu Thomson, to whom I am indebted for the loan of the apparatus, it is in my power to repeat some of these experiments before you to-night; and my obligations are likewise especially due to Mr. Ernst Thurnauer, the engineer of the European Thomson-Houston Electric Light Company, for affording me his valuable aid in bringing them before you, and to Mr. Garfield, of the Thomson Electric Welding Company, for assistance in preparing the experiments. A few introductory remarks will be essential in order that I may carry the whole of my audience with me in subsequent explanations; and these remarks will refer to that which is so very familiar a subject to every electrician—viz., the mutual induction of electric circuits. Before me lies a very large bobbin, or spool, wound over with two insulated copper wires. These wires were wound on the spool together, and for convenience sake we will distinguish them by calling them A and B (Fig. 1). Bear in mind that the wires or circuits are insulated from each other throughout their entire length, but lie closely adjacent on the bobbin. I can at pleasure insert a large bundle of soft iron wires tied up together into the hollow split brass tube which forms the body of the spool. The ends of one wire, say A, are connected to the terminals of a glow lamp, and I can pass or interrupt an electric current which traverses the other circuit, B, and a second glow lamp in series with it. You will note at once what happens when I start or stop the electric current in the circuit B. The lamp connected to circuit A flashes up momentarily at the instant when the current begins to flow in circuit B, and also when it ceases to flow; but whilst the current flows steadily in the circuit B and illuminates the lamp in series with it, the lamp in series with circuit A is not illuminated at all. We have here a lecture experiment illustrating the familiar classical discovery of Faraday of the mutual induction of two electric circuits—viz., that the starting or stopping of an electric current in one circuit induces at the instant of commencement or cessation a brief secondary current in another closed adjacent circuit. I shall not take up time by dwelling on the historical details of this fundamental fact. You know them well. If instead of starting and stopping a continuously flowing electric current through the circuit B, and observing at each "make" or "break" a brief secondary current in circuit A, we supply the circuit B with an alternating electric current, one of which the direction is rapidly reversed many times in a second, and connect as before a glow lamp in series with circuit A, we find that this lamp glows continuously whilst the alternating current flows in circuit B. This also is familiar to us all. If in our first experiment we had employed, as a current detector in the secondary circuit, not an incandescent lamp, but some kind of galvanometer capable of indicating the direction of the induced electric current, we could easily have established for ourselves the fact that at the instant when the continuous electric current begins to flow in the circuit B it generates an oppositely directed induced secondary current in the circuit A, which is merely a transient current. At the instant when the continuous current is interrupted in circuit B, it gives rise to a similarly directed transient induced electric current in the circuit A. The momentary currents in A are called the inverse and direct secondary currents, induced by the commencement or cessation of the continuous primary current in circuit B. If the primary current is rapidly reversed, as in the case of an alternating current, then the secondary current consists likewise of a rapid succession of currents alternating in direction. In most of our experiments this evening we shall employ an alternating current, having a "frequency" of 90 per second, that is to say, changed in direction in the circuit 180 times in a second, and provided for us by the kindness of the London Electric Supply Company. If such an alternating current traverses a primary circuit, it induces a secondary alternating current of the same frequency in an adjacent secondary circuit, and this secondary periodic current may be made to induce in another circuit a tertiary current of like frequency, and this, again, a quaternary current, and so on, these successive orders of induced currents being, as it were, the children,

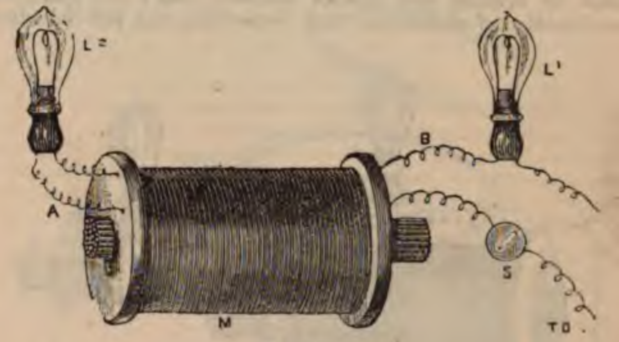


FIG. 1.

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* Paper read before the Society of Arts, May 14, 1890.

grandchildren, and great-grandchildren of the primary parent current to which they owe their birth. (Fig. 2.)

The same large spool of insulated wire will provide us with the means of illustrating another important fact. I join up the two wires, A and B, into one length, so as to form one continuous bobbin of wire, and connect this great spiral of wire with a couple of glow lamps, one being in series with the wire spiral, and the other being in parallel with it (Fig. 3). On sending a steady current through the system, it divides between the wire spiral, S, and the lamp, L_1, and I adjust the strength of this current so that the lamp, L_1, is barely visibly red hot. On interrupting suddenly this electric current, the lamp, L_1, flashes up for a moment. We recognise that we have here to consider an inertia effect familiar to us as the effect of the "self-induction" in the long coil of wire. Audiences in this room have been so carefully informed on many past occasions by brilliant and capable teachers, that I may spare you a reiteration of elementary facts concerning the self-induction or inductance of conducting circuits, and take it for granted that everyone here is intimately acquainted with them, and that you will recall to your recollection that when an E.M.F. acts upon any closed electric circuit generating in it an electric current, this self-induction exhibits itself by delaying or retarding the rise of the current strength to its full or its maximum value; and that, similarly, when the E.M.F. is withdrawn, it operates to give the current a persistence, or to retard the rate of reduction of the current strength. The convenient term "time-constant" of a circuit is employed to denote that time, expressed in fractions of a second or any other unit, which must elapse before a current rises to a certain definite fraction of its full value, when a steady E.M.F. acts upon that circuit. I will next beg you to turn a moment's attention to the electro-dynamic actions or forces which are brought into play when a circuit of any kind is subjected to electromagnetic induction in a magnetic field. Consider, for instance, a ring of copper hanging in front of the pole of an electromagnet (Fig. 4), having the plane of the ring perpendicular to the lines of magnetic force proceeding out from the pole. Let the magnet be an electromagnet, and let the pole be suddenly made a north or marked pole. Lines of magnetic force are thrust into the aperture of the ring. This magnetic flux, in accordance with a well-known law, generates an inductive E.M.F., which causes a transient current to flow round the ring in a counter clockwise direction, as looked at from the north magnetic pole. The ring becomes virtually a magnetic shell, having a north pole facing the north pole of the exciting magnet. By the fundamental laws of action between currents and magnets established by Ampère, the ring experiences a slight repulsive force, due to the electro-dynamic action between the current in the ring and the magnetic pole. The generation of the momentary induced current in the ring is accompanied by an electro-dynamic impulse tending to thrust it away from the pole. Suppose, next, that the electromagnet is demagnetised. The ring has generated in it a reverse induced current flowing in the same direction as the hands of a clock move when looked at from the magnetic pole. This is also accompanied by an electro-dynamic attraction of the ring towards the pole, but which is much more feeble than the previous repulsion. These attractions and repulsions are well seen when small discs of copper or aluminium are suspended in front of the poles of a powerful electromagnet, which is alternately "made" and "broken." They have been particularly investigated by Mr. C. V. Boys.*

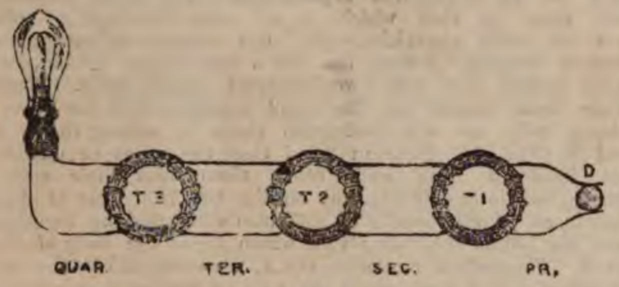

FIG. 2.

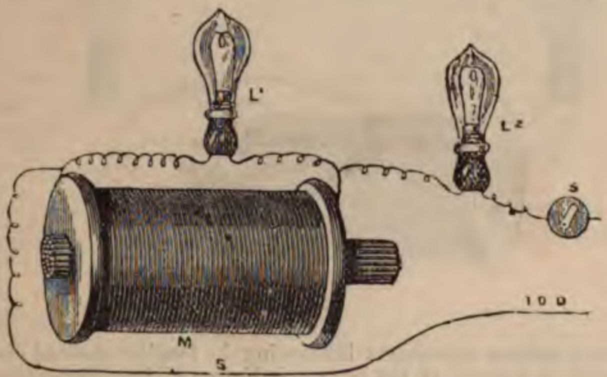

FIG. 3.

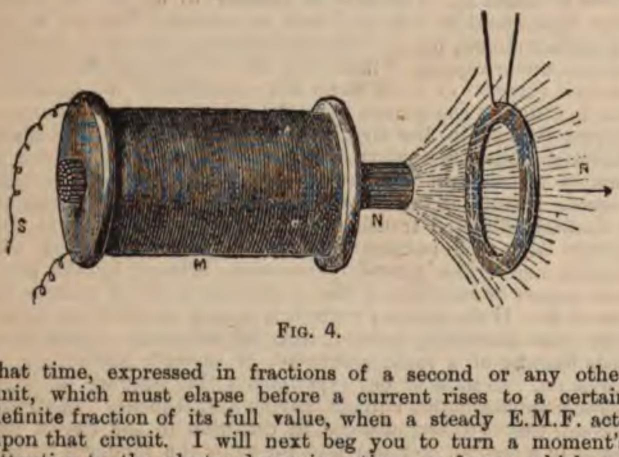

FIG. 4.

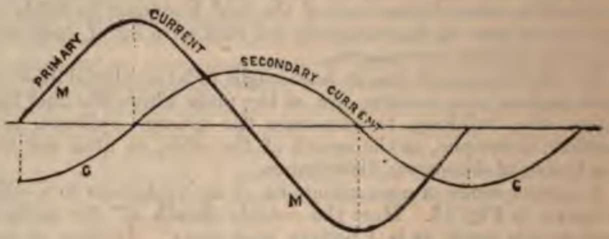

FIG. 5.

I will now ask you to consider what would happen if the coils of the electromagnet were traversed by an alternating current? Furthermore, we shall first suppose that the copper ring has a zero time-constant, that is to say, the induced currents in the ring rise up and sink down in strength in exact synchronism with the changes in the inductive E.M.F. acting on the ring. If the current flowing in the coils of the electromagnet is represented as to changes in strength by a simple periodic curve, we may suppose that the magnetism of the core and the magnetic induction through the ring follow a similar law. It is very easy, then, to show that the induced E.M.F. acting in the ring circuit, and hence the current in the ring, follows a similar law of fluctuation, but that the instant of maximum current in the ring coincides with the instant of reversal of magnetism in the electromagnet. Under these circumstances we can represent the changing strength of the magnetic field in which the ring is immersed by a simple periodic curve, m, and the changes of current strength in the ring circuit by another simple periodic curve, c, shifted backwards relatively to the first by a quarter of a wave length (Fig. 5).

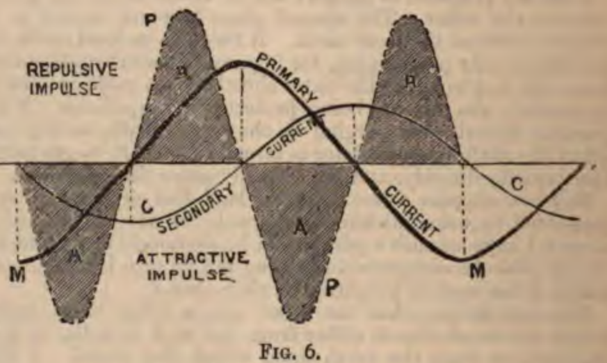

FIG. 6.

By Ampère's law the force acting on the ring at any instant is proportional to the product of the instantaneous value of the surrounding field and this current strength. If we multiply together the ordinates of these two curves, m and c, and form a third curve, p, whose ordinates at every point is proportional to the product of the ordinates of the other curves (Fig. 6) at those points, we obtain a curve which represents the fluctuation of force at every instant acting upon the ring. This curve, p, is also a wave-like curve, lying symmetrically above and below the horizontal line. The positive and negative areas of this curve included between the curve and the horizontal line represent the impulses or time integrals of the forces which act upon the ring. These impulses are alternately positive and negative.

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* "On a Magneto-electric Phenomenon." By C. V. Boys, F.R.S. *Proceedings* Phys. Soc., London, vol. vi., p. 218.

This is equivalent to saying that under the circumstances assumed the ring gets a series of small pushes and pulls, or repulsions and attraction, which succeed each other at the same rate as the changes of magnetic polarity of the magnet. The series of rapidly alternating and equal impulses would result in leaving the ring apparently unmoved. No real conducting ring can, however, behave in this fashion, because every ring has a sensible "time-constant." Let us next see how the above statements will be modified if the ring has such a sensible self-induction that the current induced in the ring lags behind the inducing E.M.F. in phase. Repeating the above construction for a force curve, on the assumption that the instant of maximum of the current in the ring occurs later than the instant of reversal of magnetism in the magnet, it is easy to see that the force curve consists now of two very unequal parts. It is not symmetrically situated with respect to the horizontal lines (*see* Fig. 7). The area of the hummocks (shaded portions) which lie above the datum line, and which represent the repulsive impulses on the ring, are much larger than the area of the hummocks below the datum line, and which represent the attractive impulses acting on the ring. This means to say, that the ring when possessing self-induction experiences on the whole a repulsive force, or a series of repulsive impulses, when immersed in such an alternating magnetic field radiated from a magnetic pole, and this repulsive force will be within certain limits more pronounced, other things being equal, the greater the time-constant of the circuit. You see clearly, therefore, that a ring or disc of copper in which the induced currents lag behind the inducing E.M.F. in phase must experience a repulsive force when this inducing E.M.F. is caused by a rapid flux backwards and forwards of lines of magnetic forces perforating through the ring or disc. The realisation of this inference in a striking manner is the first of a series of remarkable experiments on this subject due to Prof. Elihu Thomson. We have on the table an electromagnet suitable for these experiments, which consists of a core of divided iron, surrounded by a coil, in which I can cause to circulate a powerful alternating current of 40 to 50 amperes. Let us, however, begin with an experiment in which we employ a continuous current to energise the core. I give you, in Prof. Elihu Thomson's own words,* an account of this preliminary experiment :

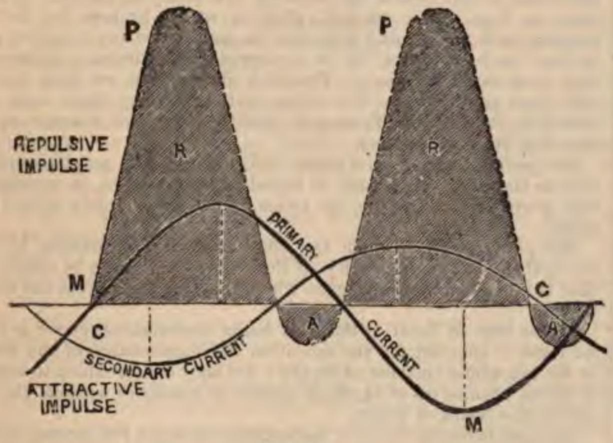

Fig. 7.

"In 1884, while preparing for the International Electrical Exhibition at Philadelphia, we had occasion to construct a large electromagnet, the cores of which were about 6in. in diameter and about 20in. long. They were made of bundles of iron rod about 5-16ths of an inch in diameter. When complete the magnet was energised by a current from a continuous-current dynamo, and it exhibited the usual powerful magnetic effects. It was found also that a disc of sheet copper of about 1-16th of an inch in thickness, and 10in. in diameter, if dropped flat against a pole of the magnet, would settle down softly upon it, being retarded by the development of currents in the disc, due to its movement in a strong magnetic field, and which currents were of opposite direction to those in the coils of the magnet. In fact, it was impossible to strike the magnet pole a sharp blow with the disc, even when the attempt was made by holding one edge of the disc in the hand and bringing it down forcibly towards the magnet. In attempting to raise the disc quickly off the pole a similar but opposite action of resistance to movement took place, showing the development of currents in the same direction as those in the coils of the magnet, and which currents, of course, would cause attraction as a result. The experiment could be tried in another way. Holding the sheet of copper by one edge, just over the magnet pole (Fig. 8), the current in the magnet-coils was cut off by shunting them. There was felt an attraction of the disc, or a dip towards the pole. The current was then put on by opening the shunting-switch, and a repulsive action or lift of the disc was felt. The actions just described are what would be expected in such a case, for when attraction took place currents had been induced in the disc in the same direction as those in the magnet-coils beneath it, and when repulsion took place the induced current in the disc was of opposite character or direction to that in the coils. Now, let us imagine the current in the magnet-coils to be not only cut off, but reversed back and forth. For the reasons just given, we find that the disc is attracted and repelled alternately; for whenever the currents induced in it are of the same direction with those in the inducing or magnet-coil, attraction will ensue, and when they are opposite in direction repulsion will be produced. Moreover, the repulsion will be produced when the current in the magnet-coil is rising to a maximum in either direction, and attraction will be the result when the current of either direction is falling to zero, since in the former case opposite currents are induced in the disc, in accordance with well-known laws, and in the latter case currents of the same direction will exist in the disc and the magnet coil. The disc might, of course, be replaced by a ring of copper or other good conductor, or by a closed coil of bare or insulated wire, or by a series of discs, rings, or coils superposed, and the results would be the same."

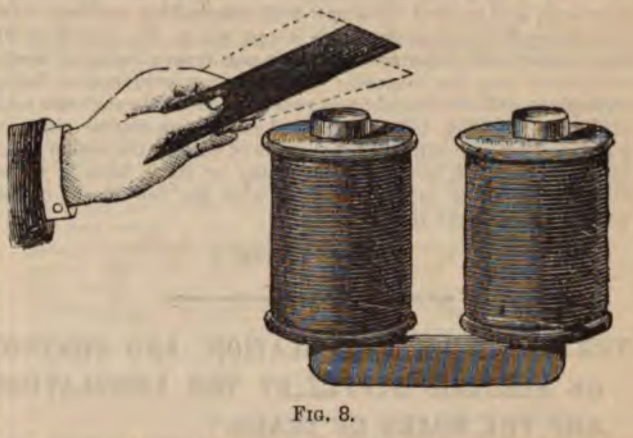

Fig. 8.

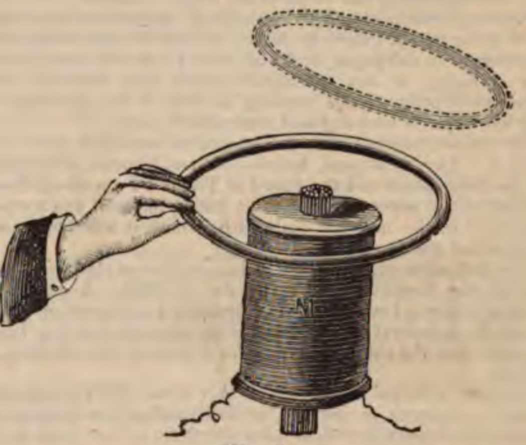

Fig. 9.

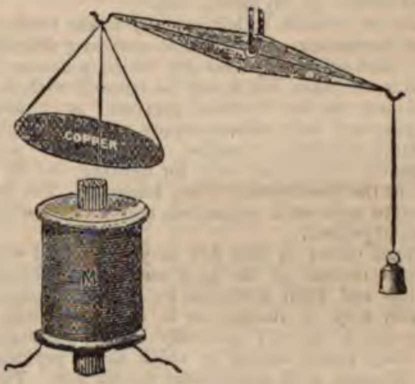

Fig. 10.

We have already seen that in an alternating field the electrodynamic impulses so experienced by the disc or ring are alternately attractive and impulsive, and that when the circuit possesses a sensible self-induction the repulsive impulses overpower the attractive ones, and their repetition constitutes a repulsive force. Before adding a few more words of explanation, permit me to show you some of these electro-dynamic repulsions produced by an alternating electromagnet. Here is a copper ring, and I lay it upon the top of this electromagnet, having a divided iron core, and excited by a powerful alternating current. On energising the magnet the ring jumps up in the air (Fig. 9). If a copper plate is hung like a scale pan from a balanced beam, and placed over the magnetic pole, it gives evidence of being strongly repelled the moment we pass the current through the coils of the magnet (Fig. 10). Instead of employing copper rings or copper plates, we can use closed coils of thick wire, either insulated or not. If, however, our plates or rings have a radial slit made in them, or if our coils of wire are not closed-circuit coils, all the effects vanish.

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* See the *Electrical World*, May, 1887, p. 258, or the *Electrical Engineer* (American), June 18, 1887, p. 211 :—"Novel Phenomena of Alternating Currents," by Elihu Thomson.

(To be continued.)

THE TREATMENT, REGULATION, AND CONTROL OF ELECTRIC SUPPLY BY THE LEGISLATURE AND THE BOARD OF TRADE.*

BY MAJOR P. CARDEW, R.E., MEMBER.

Before starting with the undertaking which in a moment of weakness I have laid upon myself, I have to ask a favour and convey a warning. The favour is that you will bear in mind that nothing I may say to-night possesses any official sanction, or can be taken as in any way expressing the views of the Board of Trade.

Before preparing the paper I obtained permission from the Department under which I serve to do so; but some rather delicate ground is traversed in the paper, and I am sure I may rely upon your forbearance to-night, in any discussion which may arise, to avoid any questions of policy. The warning is that I am painfully conscious that the paper is very dry and portentously long.

The subject which I have the honour to submit to your notice to-night is "The Treatment, Regulation, and Control of Electric Supply by the Legislature and the Board of Trade." I am afraid the scientific interest of the paper is very small; but as many of you are practically concerned in the matters dealt with, I hope it will not be considered to be out of place.

The first attempt to deal with the question of electric supply on the part of the Legislature was the Act of 1882. As notice had been given of many private Bills to be brought in to acquire the necessary powers for a general supply, proceeding on very varying lines, it was thought that the time had come for a general Act dealing with the subject.

The two principal objects of this Act were—(1) To empower electric supply companies, or persons, or local authorities desirous of undertaking this supply for their own districts, to lay their mains in the public streets, and conduct the business of supply generally in a manner recognised by law; (2) to recover charges for supply made to consumers. At the same time proper regulations and conditions were imposed upon the undertakers to secure the safety of the public and the adequacy of the supply; while the fear of creating a new perpetual monopoly was evidently present in the minds of the framers of the Act.

This Act is so familiar that a short sketch of its provisions will be sufficient. It sets out by detailing the various ways in which statutory powers can be obtained. These are—(1) By license; (2) by provisional order; (3) by special Act.

The issue of licenses is left entirely in the hands of the Board of Trade, but the consent of every local authority affected must first be obtained. The original period for which a license is granted must not exceed seven years, but it may be renewed with the like consents. A license may be for "public purposes" or "private purposes." "Public purposes" only allows supply for electric lighting of streets, public places, buildings, theatres, etc.; while "private purposes" allows general supply, not only for lighting, but for any other purpose, except the transmission of any telegram. The Board of Trade is empowered to make such regulations and conditions in a license as it may think expedient.

Provisional orders in this Act may be granted without requiring the previous consent of the local authorities affected, but have no force unless and until confirmed by Act of Parliament. The period of an order may be limited, or it may be unlimited in duration. There appears to be very generally diffused a mistaken idea on this point. Many people appear to think that a provisional order only lasts for 42 years, or 21 years under the old Act. This was stated in the *Times* the other day as a fact. It is, however, quite a mistake. The orders granted by the Board of Trade, and confirmed by Parliament, have hitherto been, without exception, I think, unlimited in duration. There are various provisions for sale or transfer of the undertaking, including, in the case of a company, compulsory sale to the local authority; but these provisions may never be acted upon, and even if they are put into force do not extinguish the powers granted.

Section 6, with respect to regulations, is so important that it will be better to read the exact words—

6. The undertakers shall be subject to such regulations and conditions as may be inserted in any license, order, or special Act affecting their undertaking with regard to the following matters:

(*a.*) The limits within which and the conditions under which a supply of electricity is to be compulsory or permissive;

(*b.*) The securing a regular and efficient supply of electricity;

(*c.*) The securing the safety of the public from personal injury, or from fire or otherwise;

(*d.*) The limitation of the prices to be charged in respect of the supply of electricity;

(*e.*) The authorising inspection and enquiry from time to time by the Board of Trade and the local authority;

(*f.*) The enforcement of the due performance of the duties of the undertakers in relation to the supply of electricity by the imposition of penalties or otherwise, and the revocation of the license, order, or special Act where the undertakers have, in the opinion of the Board of Trade, practically failed to carry the powers granted to them into effect within a reasonable time, or discontinued the exercise of such powers; and

(*g.*) Generally with regard to other matters in connection with the undertakings.

Provided always that the Board of Trade may from time to time make such regulations as they may think expedient for securing the safety of the public from personal injury or from fire or otherwise, and may from time to time amend or repeal any regulations which may be contained in any such license, order, or special Act in relation thereto; and any regulations so made or amended by the Board of Trade shall, from and after the date thereof, have the like effect in every respect as though they had been originally inserted in the license, order, or special Act authorising the undertaking; and every regulation so repealed shall, from and after the date thereof, be repealed accordingly, but such repeal shall not affect any liability or penalty incurred in respect thereof prior to the date of such repeal, or any proceeding or remedy which might have been had in relation thereto.

Any local authority within any part of whose district electricity is authorised to be supplied under any license, order, or special Act may, in addition to any regulations which may be made under the preceding provisions of this section for securing the safety of the public, from time to time make, rescind, alter, or repeal by-laws for further securing such safety; and there may be annexed to any breach of such by-laws such penalties, to be recovered in a summary manner, as they may think necessary: Provided always that no such by-laws shall have any force or effect unless and until they have been confirmed by the Board of Trade and published in such manner as the Board of Trade may direct.

The proviso enabling the Board of Trade to make regulations from time to time, and to amend or repeal any regulations, is certainly a wise provision, and, as you are aware, it has been largely carried into effect.

The power conferred upon the local authority of making by-laws for further securing the safety of the public should also be noted, and that this may be exercised even where they are themselves the undertakers.

In the case of local authorities being undertakers, power is given for them to contract for the execution and maintenance of any works, or for the whole business of supply; but they are forbidden to transfer or divest themselves of any legal powers or liabilities without the consent of the Board of Trade.

As regards overhead wires, undertakers must get the express consent of the local authority for their erection along, over, or across any street, and the local authority may remove any electric line placed above ground without such consent, and, even where such consent has been given, a court of summary jurisdiction may order the removal of any electric line, on the ground of public safety.

It must be noticed, however, that nothing in this Act empowers any interference on the part of the Board of Trade or any other authority with electric lines erected by persons who are not undertakers. The undertakers are not allowed to prescribe any special form of lamp, or to interfere with the use made by any consumer of the supply given to him; but no consumer is to deal with his supply in such a manner as to unduly or improperly interfere with the supply to other consumers; and any dispute as to this is to be determined by arbitration.

There are provisions against undue preference on the part of the undertakers in their supply and charges. I take the meaning of these sections (19 and 20) to be this—that the undertakers may make any agreement as regards price, hours of supply, etc., provided that the price is not in excess of the maximum rates laid down; but that, where they have made any such agreement with any private consumer, any other private consumer may demand a similar agreement, where the conditions are similar; and so in the case of street lighting authorities; but not that a private consumer could demand to be supplied at the same rate as is agreed upon for the street lighting or for lighting a large theatre.

Supply may be cut off for neglect of payment of charges due, but only until these charges and any expenses incurred in cutting off the supply are fully paid.

Any unlawful and malicious injury of electric lines and works is made a felony, and any person who maliciously or fraudulently abstracts, causes to be wasted or diverted, consumes or uses, electric energy is declared to be guilty of simple larceny—in fact, to have stolen it.

The purposes for which the officers of the undertakers may enter premises of consumers are strictly defined, and they have no legal right of entry for any other purpose—*e.g.*, to inspect the electric lines and fittings of the consumer.

The Board of Trade has, however, so framed the orders and safety regulations as to make it unlikely that any consumer would refuse entry to a properly authorised agent of the undertakers, if required by them to make an inspection of these electric lines and fittings.

In the section of the Act providing for the protection of the Postmaster-General, it is curious to note that a distance of 10 yards was apparently considered as the outside limit of distance within which a telegraph line might be affected by an electric supply line.

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* Paper read before the Institution of Electrical Engineers.

The section dealing with compulsory purchase by the local authority after 21 years has been made the scapegoat for the failure of the electric lighting "boom" of 1883. It is questionable, however, whether it had so much effect as is attributed to it in preventing capitalists from coming forward to support electric lighting schemes, and also whether whatever checking influence was really due to it has not in the long run been as beneficial as a nipping frost in early spring in restraining youthful impetuosity.

And I may remark that this clause did not excite any serious opposition at the time; in fact, the Bill was sent up from the Commons with a 15 years limit, and extended in the Lords to 21 years, which was considered an ample time even by the persons best qualified to judge, as is amply demonstrated in the minutes of evidence given before the Parliamentary Committee.

In the amending Act of 1888 the first section has two important provisions—

> 1. Notwithstanding anything in the Electric Lighting Act, 1882, no provisional order authorising the supply of electricity by any undertakers within the district of any local authority shall be granted by the Board of Trade except with the consent of such local authority, unless the Board of Trade, in any case in which the consent of such local authority is refused, are of opinion that, having regard to all the circumstances of the case, such consent ought to be dispensed with; and in such case they shall make a special report, stating the grounds upon which they have dispensed with such consent. The grant of authority to any undertakers to supply electricity within any area, whether granted by license or by means of a provisional order, shall not in any way hinder or restrict the granting of a license or provisional order to the local authority, or to any other company or person within the same area.

The second section repeals section 27 of the former Act, and substitutes 42 years for 21 as the time to elapse before compulsory purchase can be enforced.

Section 3 gives power to the Board of Trade to vary the terms of compulsory sale in accordance with any agreement between the local authority and the undertakers.

Section 4 is very important, as it empowers the Board of Trade to make regulations for the protection of the public safety and of telegraphic and telephonic lines in the case of any electric lines used for the supply of electric energy, however laid or erected, and whether under statutory powers or not. Perhaps I had better read the first part of this section:

> 4.—(1.) Where in any case any electric line or other work may have been laid down or erected in, over, along, across, or under any street, for the purpose of supplying electricity, or may have been laid down or erected in any other position for such a purpose in such a manner as not to be entirely enclosed within any building or buildings, or where any electric line or work so laid down or erected may be used for such purpose otherwise than under and subject to the provisions of a license, order, or special Act, the Board of Trade, if they think fit, may, by notice in writing under the hand of one of the secretaries or assistant secretaries of the Board of Trade, to be served upon the body or person owning or using or entitled to use such electric line or work, require that such electric line or work shall be continued and used only in accordance with such conditions and subject to such regulations for the protection of the public safety and of the electric lines and works of the Postmaster-General, and of other electric lines and works lawfully placed in any position and used for telegraphic communication, as the Board of Trade may by or in pursuance of such notice prescribe; and in case of non-compliance with the said regulations, then the Board of Trade may require such body or person to remove such electric line or work: Provided that nothing in this sub-section shall apply to any electric line or work laid down or erected by any body or person for the supply of electricity generated upon any premises occupied by such body or person to any other part of such premises.

Sub-section (2) provides for the Postmaster-General taking action himself in the case of lines not laid under statutory powers, in the event of actual interference with his telegraphic lines, provided that these lines are not already regulated by the Board of Trade. The general purport of the section is to place the responsibility for the proper regulation of electric supply wires generally on the Board of Trade.

We now come to the dealings of the Board of Trade with the subject, and I propose to consider in the first place the various forms of provisional orders granted under the general Acts. As licenses differ very slightly in form from orders of the same date, it will not be necessary to discuss them.

There are up to the present time four forms of orders, differing materially from each other in important respects, and showing, I consider, progressive improvement in the treatment of the subject as experience was gained.

These are—1st. The 1883 form, of which Bradford is, I think, the only one now actually being worked, but some other local authorities are preparing to start under old orders; 2nd. The Chelsea Order of 1886, and St. Austell License of 1885; 3rd. The London Orders of last year, which form, I may point out, is only applicable to metropolitan districts under the London County Council; 4th. The model forms of orders for this year, which are even now being modified in certain clauses, and will not attain finality until some points have been determined by the action of Parliament.

There are slight variations in form among individual orders, generally due to some local considerations, and in every case there are considerable differences between orders granted to local authorities and those granted to companies.

The first matter in all the orders is the interpretation clause. In this, last year an innovation very important to electricians was introduced—viz., the definitions of "energy" and "power"—

> The expression "energy" shall mean electrical energy, and for the purposes of applying the provisions of the principal Act to this order electrical energy shall be deemed to be an agency within the meaning of electricity as defined in the Electric Lighting Act of 1882. And the expression "power" shall mean electrical power, or the rate per unit of time at which energy is supplied.

They hang upon the definition of electricity in the principal Act as "electricity, electric current, or any like agency." Rather a general definition, you see.

Now the use of the term "energy" has, I consider, materially improved the language of the orders, both from a scientific and a legal point of view. Under the old forms of orders the undertakers were authorised to supply "electricity," and continual reference is made to this as the quantity supplied. Now this word has, or had, many meanings, but in this case it could only mean electrical energy. But when we return to the "price" clauses we find that energy is expressly mentioned as differing from electricity, and that there, at all events, the latter meant what we now call "electrical quantity." There really was here some confusion of language, distressing to the electrician and opening up grand possibilities of endless talk to lawyers. The proposed amendment was referred to your council and concurred in by them, and I am glad to notice that the use of the term "electrical energy" is gradually working its way.

I am not yet satisfied, however, with our word for what used to be the particular meaning of electricity. It is rather absurd to call it "electrical quantity," since so many other things are electrical quantities. I almost think we want a word for this even more urgently than for electrical locomotion, over which so much ingenuity has been lately expended. The worst of it is that, as nobody knows what it is, or to what extent its existence is an objective reality, it is difficult to find an appropriate word. At any rate, it was impossible in the orders to call it "electricity" any longer, as the Act says that is what is to be supplied; so that we had to define "energy" as what was meant by electricity in the Act, and use "electrical quantity" for the particular meaning for want of a better word.

This also necessitated an alteration in the title. There is a slight further alteration in the new model title.

As regards the definition of "power," this was necessary to avoid a difficulty in modifying a few clauses in the old orders which dealt with the maximum current to any consumer to render them applicable to transformer systems.

The definition of "main" has been materially altered. Thus it used to mean the conductor alone, then a continuous electric line, defined in the Act as follows:

> The expression "electric line" means a wire or wires, conductor, or other means used for the purpose of conveying, transmitting, or distributing electricity with any casing, coating, covering, tube, pipe, or insulator enclosing, surrounding, or supporting the same, or any part thereof, or any apparatus connected therewith for the purpose of conveying, transmitting, or distributing electricity or electric currents.

And, lastly, the word "continuous" has been omitted as unnecessary in the case of transformer systems.

The definition of "service line" has been altered in the same way.

"Distributing main" has not been altered. It is a very important definition, which I will read—

> The expression "distributing main" shall mean the portion of any main which is used for the purpose of giving origin to service lines for the purpose of general supply.

Difficulties may arise in interpreting this, as, for instance, in cases where the same conductor is at one part a feeder and at another a distributing main; but it is one of those things which must be left to custom and precedent.

The other definitions need not detain us now, except that two important ones have been added in the new forms—

> The expression "consumer" shall mean any body or person supplied or entitled to be supplied with energy by the undertakers.
>
> The expression "consumer's terminals" shall mean the ends of the electric lines situate upon any consumer's premises and belonging to him, at which the supply of energy is delivered from the service lines.

The consumer's terminals are the point of demarcation between the possessions of the undertakers and their customers; they need not be binding posts.

In the clauses headed "Area of Supply," an important novelty was introduced last year, and has been retained in the new model for companies, expressly prohibiting the undertakers from supplying outside the area granted to them without further statutory powers. This is a sacrifice of their common law rights which they are required to make in consideration of the special privileges they acquire. You are perhaps aware that this provision is being carried out by mutual agreements between the London companies.

The old orders, and the Liverpool and Swansea Orders of last year, provided for the division of the whole area into two districts, scheduled A and B respectively; the A district alone being the area for which powers are immediately granted, and in which supply is compulsory; while the B district was intended to be added piece by piece, practically at the option of the undertakers.

The general effect of this was to induce undertakers to apply for very large districts, the greater part of which were in the B schedules, over which they thereby acquired a sort of prior right of occupation without incurring any liability. This was altered last year and a single district substituted, to the whole of which the "Compulsory Works'" clauses apply.

(*To be continued.*)

PROVISIONAL ORDER.

FORM II.—UNDERTAKERS BEING A COMPANY OR PERSON.

(*Continued from page 396.*)

TESTING AND INSPECTION.

39. On the occasion of the testing of any main of the undertakers reasonable notice thereof shall be given to the undertakers by the electric inspector, and such testing shall be carried out at such suitable hours as in the opinion of the inspector will least interfere with the supply of energy by the undertakers, and in such manner as the inspector may think expedient, but except under the provisions of a special order in that behalf made by the Board of Trade he shall not be entitled to have access to or interfere with the mains of the undertakers at any points other than those at which the undertakers have reserved for themselves access to the said mains : Provided that the undertakers shall not be held responsible for any interruption in the supply of energy which may be occasioned by or required by such inspector for the purpose of any such testing as aforesaid. Provided also that such testings shall not be made in regard to any particular portion of a main oftener than once in any three months, unless in pursuance of a special order in that behalf made by the Board of Trade.

40. An electric inspector, if and when required to do so by any consumer, shall from time to time, on payment by the consumer of the prescribed fee, test the variation of electric pressure at the consumer's terminals, or make such other inspection and testing of the service lines, apparatus, and works of the undertakers upon the consumer's premises as may be necessary for the purpose of determining whether the undertakers have complied with the provisions of this order, and the regulations and conditions subject to which they are for the time being authorised to supply energy.

41. The undertakers shall at such places, within a reasonable distance from a distributing main, establish at their own cost and keep in proper condition such reasonable number of testing stations as the local authority, or, where the local authority are the undertakers, as the Board of Trade shall deem sufficient for testing the supply of energy by the undertakers through such main, and shall place thereat proper and suitable instruments of a pattern to be approved by the Board of Trade, and shall connect such stations by means of proper and sufficient electric lines with such mains, and supply energy thereto for the purpose of such testing.

If any dispute arises between the local authority and the undertakers as to whether the number of such testing stations and the distance from the main at which they are established is reasonable or excessive, or as to any excessive or improper use of energy for such testing, or as to the performance by the undertakers of their duties under this section, such dispute shall be determined by arbitration.

42. The undertakers shall set up and keep upon all premises from which they supply energy by any distributing mains such suitable and proper instruments of such pattern and construction as may be from time to time approved of or prescribed by the Board of Trade, and shall from time to time take and record, and keep recorded, such observations as the Board of Trade may from time to time prescribe, and any observations so recorded shall be receivable in evidence.

43. The undertakers shall keep in efficient working order all instruments which they are required by or under this order to place, set up, or keep at any testing station or on their own premises, and any electric inspector appointed under this order may from time to time examine and record the readings of such instruments at such times and in such manner as he may be directed by the authority by whom he is appointed, and any readings so recorded shall be receivable in evidence.

44. Any electric inspector appointed under this order shall have the right to have access at all reasonable hours to the testing stations and premises of the undertakers for the purpose of testing the electric lines and instruments of the undertakers, and ascertaining if the same are in order, and in case the same are not in order he may require the undertakers forthwith to have the same put in order.

45. The undertakers may, if they think fit, on each occasion of the testing of any main or service line, or the testing or inspection of any instruments of the undertakers by any electric inspector, be represented by some officer or other agent, but such officer or agent shall not interfere with the testing or inspection.

46. The undertakers shall afford all facilities for the proper execution of this order with respect to inspection and testing and the readings and inspection of instruments, and shall comply with all the requirements of or under this order in that behalf ; and in case the undertakers make default in complying with any of the provisions of this section they shall be liable in respect of each default to a penalty not exceeding £5, and in case of a continuing offence to a further penalty not exceeding £1 for every day after the first day during which such offence continues.

47. Every electric inspector shall, on the day immediately following that on which any testing has been completed by him under this order, make and deliver a report of the results of his testing to the local authority, Board of Trade, or consumer (as the case may be) by whom he was required to make such testing, and to the undertakers, and such report shall be receivable in evidence.

If the undertakers, the local authority, or any consumer are or is dissatisfied with any report of any electric inspector they or he may appeal to the Board of Trade against such report, and thereupon the Board of Trade shall enquire into and decide upon the matter of any such appeal, and their decision shall be final and binding on all parties.

48. Save as otherwise provided by this order, or by any regulations under this order, all fees and reasonable expenses of an electric inspector shall, unless agreed, be ascertained by a court of summary jurisdiction or (where the inspector is appointed by them) by the Board of Trade, and shall be paid by the undertakers.

Provided that where the report of an electric inspector, or the decision of the Board of Trade, shows that any consumer was guilty of any default or negligence, such fees and expenses shall, on being ascertained as above mentioned, be paid by such consumer or consumers as the court or Board, having regard to such report or decision, shall direct, and may be recovered summarily as a civil debt.

Provided also that in any proceedings for penalties under this order any such fees and expenses incurred in connection with such proceedings shall be payable by the complainant or defendant as the court shall direct.

METERS AND APPARATUS.

49. The amount of energy supplied by the undertakers to any ordinary consumer under this order, or the electrical quantity contained in such supply (according to the method by which the undertakers elect to charge), in this order referred to as "the value of the supply," shall, except as otherwise agreed between such consumer and the undertakers, be ascertained by means of an appropriate meter duly certified under the provisions of this order.

50. A meter shall be considered to be duly certified under the provisions of this order if it be certified by an electric inspector appointed under this order to be a correct meter, and to be of some construction and pattern and to have been fixed and to have been connected with the service lines in some manner approved of by the Board of Trade ; and every such meter is in this order referred to as a "certified meter" : Provided that where any alteration is made in any certified meter, or where any such meter is unfixed or disconnected from the service lines, such meter shall cease to be a certified meter unless and until it be again certified as a certified meter under the provisions of this order.

51. Every electric inspector, on being required to do so by the undertakers or by any consumer, and on payment of the prescribed fee by the party so requiring him, shall examine any meter intended for ascertaining the value of the supply, and shall certify the same as a certified meter if he considers it entitled to be so certified.

52. Where the value of the supply is under this order required to be ascertained by means of an appropriate meter, the undertakers shall, if required so to do by any consumer, supply him with an appropriate meter, and shall, if required so to do, fix the same upon the premises of the consumer and connect the service lines therewith, and procure such meter to be duly certified under the provisions of this order, and for such purposes may authorise and empower any officer or person to enter upon such premises and execute all necessary works and do all necessary acts; provided that previously to supplying any such meter the undertakers may require such consumer to pay to them a reasonable sum in respect of the price of such meter, or to give security therefor, or (if he desires to hire such meter) may require him to enter into an agreement for the hire of such meter as hereinafter provided.

53. No consumer shall connect any meter used or to be used under this order for ascertaining the value of the supply with any electric line through which energy is supplied by the undertakers, or disconnect any such meter from any such electric line, unless he has given to the undertakers not less than 48 hours' notice in writing of his intention so to do, and if any person acts in contravention of this section he shall be liable for each offence to a penalty not exceeding 40s.

54. Every consumer shall at all times at his own expense keep all meters belonging to him, whereby the value of the supply is under this order to be ascertained, in proper order for correctly registering such value, and in default of his so doing the undertakers may cease to supply energy through such meter.

The undertakers shall have access to and be at liberty to take off, remove, test, inspect, and replace any such meter at all reasonable times : Provided that all reasonable expenses of and incident to any such taking off, removing, testing, inspecting, and replacing, and the procuring such meter to be again duly certified where such re-certifying is thereby rendered necessary, shall, if the meter be found to be not in proper order, be paid by the consumer, but if the same be in proper order, all expenses connected therewith shall be paid by the undertakers.

55. The undertakers may let for hire any meter for ascertaining the value of the supply and any fittings thereto, and any other apparatus required for their undertaking, for such remuneration in money, and on such terms with respect to the repair of such meter or apparatus and fittings, and for securing the safety and return to the undertakers of such meter or apparatus and fittings as may be agreed upon between the hirer and the undertakers, or in case of difference decided by the Board of Trade, and such remuneration shall be recoverable by the undertakers summarily as a civil debt.

56. The undertakers shall, unless the agreement of hire otherwise provides, at all times, at their own expense, keep all meters let for hire by them to any consumer, whereby the value of the supply is ascertained, in proper order for correctly registering such value, and in default of their so doing the consumer shall not be liable to pay rent for the same during such time as such default continues. The undertakers shall, for the purposes aforesaid, have access to and be at liberty to remove, test, inspect, and replace any such meter at all reasonable times : Provided that the expenses of procuring any such meter to be again duly certified where such recertifying is thereby rendered necessary shall be paid by the undertakers.

57. If any difference arises between any consumer and the undertakers as to whether any meter, whereby the value of the supply is ascertained (whether belonging to such consumer or the undertakers), is or is not in proper order for correctly registering such value, or as to whether such value has been correctly registered in any case by any meter, such difference shall be determined upon the application of either party by an electric inspector or, where the local authority are

the consumers, by an inspector to be appointed by the Board of Trade, who shall also order by which of the parties the costs of the proceedings before him shall be paid, and the decision of such inspector shall be final and binding on all parties. Subject as aforesaid, the register of the meter shall be conclusive evidence in the absence of fraud of the value of the supply.

58. Where any consumer who is supplied with energy by the undertakers from any distributing main is provided with a certified meter for the purpose of ascertaining the value of the supply, and the undertakers change the method of charging for energy supplied by them from such main, the undertakers shall pay to such consumer the reasonable expenses to which he may be put in providing a new meter for the purpose of ascertaining the value of the supply according to such new method of charging, and such expenses may be recovered by the consumer from the undertakers summarily as a civil debt.

59. In addition to any meter which may be placed upon the premises of any consumer to ascertain the value of the supply, the undertakers may from time to time place upon his premises such meter or other apparatus as they may desire for the purpose of ascertaining or regulating either the amount of energy supplied to such consumer, or the number of hours during which such supply is given, or the maximum amount of such supply, or any other quantity or time connected therewith: Provided that such meter or apparatus shall be of some construction and pattern, and shall be fixed and connected with the service lines in some manner approved by the Board of Trade, and shall be supplied and maintained entirely at the cost of the undertakers, and shall not, except by agreement, be placed otherwise than between the mains of the undertakers and the consumer's terminals.

MAPS.

60. The undertakers shall forthwith, after commencing to supply energy under this order, cause a map to be made of the area of supply on a horizontal scale of at least 1in. to 88ft., and shall cause to be marked thereon the line of all their then existing mains, service lines, and other underground works and distributing boxes, and shall also cause to be made sections on the same horizontal scale as the map, and on a vertical scale of at least 1in. to 11ft., showing the line and level of all their existing mains and underground works other than service lines, and shall once in every year cause such map and sections to be duly corrected so as to show the then existing lines and levels.

Every map and section so made or corrected for the undertakers, or a copy thereof, with the date expressed thereon of the last time when it was so corrected, shall be kept by the undertakers at their principal office within the area of supply, and a copy of every such map and section shall, within one month after the same is made or corrected, be served by the undertakers upon the Board of Trade and upon the Postmaster-General, and (so long as they are not the undertakers) upon the local authority.

Every copy of such map and section so served upon the local authority (or, if they become the undertakers, made or corrected for them) shall be kept by them at their office, and shall at all reasonable times be open to the inspection of all applicants, and such applicants may take copies of the same or any part thereof. The local authority may demand and take from every such applicant as aforesaid such fee, not exceeding 1s. for each inspection of such map, section, or copy, and such further fee, not exceeding 1s. for each copy of the same or any part thereof taken by such applicant, as they may from time to time prescribe.

If the undertakers fail to comply with any of the requirements of this section with respect to maps and sections they shall for every such offence be liable to a penalty not exceeding £10, and to a further penalty not exceeding £2 for every day after the first day during which such offence continues.

SPECIAL PROVISIONS IN CASE OF TRANSFER.

61. If the local authority become the undertakers for the purposes of this order the following provisions shall have effect:

All moneys from time to time received by the undertakers in respect of the undertaking, except borrowed money, shall be applied by them as follows:

(1.) In payment of the working and establishment expenses and cost of maintenance of the undertaking, including all costs, expenses, penalties, and damages incurred or payable by the undertakers consequent upon any proceedings by or against the undertakers, their officers, or servants, in relation to the undertaking.

(2.) In payment of the interest or dividend on any mortgages, stock, or securities granted and issued by the undertakers in respect of money borrowed for electricity purposes.

(3.) In providing any instalments or sinking fund required to be provided in respect of moneys borrowed for electricity purposes.

(4.) In payment of all other their expenses of executing this order, not being expenses properly chargeable to capital.

(5). In providing a reserve fund, if they think fit, by setting aside such money as they may from time to time think reasonable, and investing the same, and the resulting income thereof in Government securities, or in any other securities in which trustees are by law for the time being authorised to invest, other than stock or securities of the undertakers, and accumulating the same at compound interest until the fund so formed amounts to one-tenth of the aggregate capital expenditure on the undertaking, which fund shall be applicable from time to time to answer any deficiency at any time happening in the income of the undertakers from the undertaking, or to meet any extraordinary claim or demand at any time arising against the undertakers in respect of the undertaking, and so that if that fund is at any time reduced it may thereafter be again restored to the prescribed limit and so from time to time as often as such reduction happens.

The undertakers shall carry the net surplus remaining in any year and the annual proceeds of the reserve fund, when amounting to the prescribed limit, to the credit of the local rate as defined by the principal Act, or at their option shall apply such surplus, or some part thereof, to the improvement of the borough and public benefit of the inhabitants, or in reduction of the capital moneys borrowed for electricity purposes.

Provided always that if the surplus in any year exceed £5 per centum per annum upon the aggregate capital expenditure on the undertaking, the undertakers shall make such a rateable reduction in the charge for the supply of energy as in their judgment will reduce the surplus to the said maximum rate of profit, but this proviso shall only apply to so much of the undertaking as shall for the time being remain in the hands of the local authority.

Any deficiency of income in any year shall be charged upon and payable out of the local rate.

62. If the local authority become the undertakers for the purposes of this order the following provision shall have effect:

Subject to the provisions of this order and the principal Act the undertakers may from time to time by agreement purchase or take on lease any lands for the purposes of this order, and may use such lands and any other lands which may for the time being belong to or be vested in or leased by them and may not be dedicated to the public as a park or recreation ground or be appropriated as a cemetery for the purposes aforesaid, and may from time to time dispose of any lands acquired by them under the provisions of this section which may not for the time be required for the purposes of this order: Provided that the amount of land so used by them shall not at any one time exceed in the whole five acres, except with the consent of the Board of Trade.

63. If the local authority become the undertakers for the purposes of this order, the provisions of sections 264 and 265 of the Public Health Act, 1875, shall be incorporated with this order, and in the construction of the said provisions "this Act" shall mean this order and the principal Act, and the "local authority" shall mean the local authority as such undertakers.

(To be continued.)

LEGAL INTELLIGENCE.

ALLEGED DEFECTIVE MACHINERY.—ACTION AGAINST ELECTRICAL ENGINEERS.

On Monday last the case of Reece *v.* Latimer Clark was before his Honour Judge Bayley, at the Westminster County Court, and involved a question of considerable importance to users of machinery. The action was brought by the plaintiff to recover damages by way of compensation for a serious injury inflicted upon his hand in consequence, as he alleged, of the defective condition of a drilling machine belonging to the defendant company.

The plaintiff, Mr. Charles Reece, who conducted his own case, said he was a telegraph and electrical instrument maker. On January 16 last he was employed at the company's works at Regency-street, Westminster, when, for the purpose of completing a job which he was doing, he had to use the steam drilling machine. He had used the machine once, and was clearing out the base for the purpose of using it a second time, when, without the slightest warning, the drill ran suddenly down and caught his hand, cutting a piece of flesh completely out and injuring the sinews. The injuries were so serious that he was unable to do any work for fourteen weeks, and he could not now earn more than 3d. per hour, whereas his previous earnings were 9d. an hour. He had to attend the Westminster Hospital regularly for six weeks, and was there attended by Dr. Taylor.

Cross-examined: He well understood the mechanism of the machine, and believed it had either a broken spring, or was without a spring altogether. He was not aware that the upward and downward movement of the centre bit was regulated by screws. He always knew there was something faulty about the machine, but never complained to his foreman or to anyone else.

Mr. F. P. Taylor, senior house surgeon at Westminster Hospital, described the injuries from which he found the plaintiff suffering, and said that a piece of flesh, about an inch square, had been completely cut out. The wound was now healed up, but he thought the plaintiff would always suffer from a certain amount of stiffness or contraction, and that his hand would never be quite so useful as it was before.

Wm. Dearing, an instrument maker, said he was in the employ of the defendant's firm at the same time as the plaintiff. He did not see the accident happen, but was close by at the time, and went to his assistance. The machine in question was always out of order, and the men never used it if they could possibly get at the others. No one complained about it, as no notice would have been taken if they had.

Thomas Oakes, a toolmaker, at that time in defendant's employ, said there was no doubt in his mind whatever that the machine was faulty. In his opinion the spring was broken, and there was nothing to regulate the movement of the centre bit.

Frank Carpenter, another workman, gave it as his opinion that the machine was defective; in fact, it was common knowledge among the men that such was the case. He did not tell the foreman about it because he did not think it his duty to tell the foreman his work.

For the defence, **Mr. James Pullen** was called, and said he was foreman at the defendants' works. There was absolutely no truth in the statement that the machine was faulty or defective. It had been constantly working for the past five years, and was in just as good condition now as when it was first started. It was a perfectly safe machine if used with ordinary care. There were screws by which the working of the centre-bit was regulated, and it was doubtless owing to the plaintiff's neglect in not looking to the screws that the drill came down upon him. It was a simple machine, and the plaintiff as a mechanic should have seen that the screws were sufficiently tight. He (witness) had never had a single complaint made to him about the machine, or it would at once have received attention.

Mr. John Farquarson, an electrical engineer, attached to Sheerness Dockyard, said he had had many years' experience of all kinds of machines. He had made a minute examination of the one in question and found it to be in a perfect working condition, and so far as he could see there was absolutely nothing wrong with it. There were screws at the side of the machine by which its working was regulated, and had those screws been made proper use of the accident would not have happened. Whether a machine was faulty or not he considered it a very imprudent thing on the part of the plaintiff to have put his hand in such a position beneath it as to get caught if the drill came down. The machine in question was an American invention, and was very extensively used for small drilling work, but was not at all a dangerous machine to work.

That being the whole of the evidence, his **Honour** said that after hearing the evidence of the deputy foreman, and that of Mr. Farquarson, who was evidently a good authority on the subject, he could come to no other conclusion than that the machine was not defective, but that the accident was the outcome of the plaintiff's negligence; therefore judgment would be entered for the defendants.

NEW COMPANIES REGISTERED.

Devon and Cornwall Electricity Supply Company, Limited.—This Company has been formed for the purpose of establishing in the leading towns of Devon and Cornwall central stations at which electricity can be generated on a large and economical scale, and thence distributed by means of mains and conductors. The capital is £100,000 in 19,900 ordinary and 100 founders' shares of £5 each. The profits of each year are applicable first to the payment of a dividend at the rate of 7 per cent. per annum on the amount paid up upon the ordinary shares, and one-half of the surplus profits belong to the holders of the ordinary shares, and the other half to the holders of the founders' shares. The issue is now announced of 14,900 ordinary shares and the founders' shares.

Electric and General Investment Company, Limited.—This Company has been formed, announcing a capital of £200,000 in 40,000 £5 shares, of which 100 are founders' shares, and the remaining 39,900 ordinary shares. The present issue is of £100,000 in 20,000 ordinary shares, and £500 in 100 founders' shares. The founders' shares have, it is stated, been subscribed for, and the subscribers are bound, if required, to take the whole of the present issue of ordinary shares, but no preference will be given to holders of the founders' shares in the allotment. The holders of the ordinary shares will receive 10 per cent. out of the profits of each year, and the surplus profits will be divided in equal proportions between the founders and the ordinary shareholders. The Company has been formed primarily for the purpose of facilitating the promotion and development of undertakings for electric lighting, traction, transmission of power, and for other industrial uses of electricity.

CITY NOTES.

Western and Brazilian Telegraph Company.—The receipts for the week ended May 16th were £2,896.

Brazilian Submarine Telegraph Company.—The receipts for the week ended May 16th amounted to £3,765.

West India and Panama Telegraph Company.—The estimated receipts for the half-month ended May 15th were £3,209, against £3,151.

PROVISIONAL PATENTS, 1890.

MAY 12.

7373. **Improvements in electric switches.** George Septimus Hooker, 4, South-street, Finsbury, London.

7378. **Improvements in electrical switches.** Achille Brüll, 28, Southampton-buildings, London.

7383. **An improved battery element.** Jacobus Nicolaas Levsen, Monument-chambers, King William-street, City. (Complete specification.)

MAY 13.

7390. **Improvements in heating by magnetism and electricity.** Rankin Kennedy, 10, India-street, Kilmarnock.

7422. **Improvements in appliances used for protecting or regulating an electrical circuit.** Frank Bryan, 11, Brackley-terrace, Chiswick, London.

7425. **Improvements in the method of producing alternating electric currents.** Mahlon S. Couly, 45, Southampton-buildings, London. (Complete specification.)

7433. **Improvements in telephones.** William Vogel and Gary Giles Calkins, 45, Southampton-buildings, London. (Complete specification.)

7436. **Improvements in switches for electric currents.** Bernhard Dukes, 226, High Holborn, London. (Carl Friedrich Richard Bosse, Germany.)

7444. **Improvements in and relating to galvanic batteries.** André Million and Pierre Bony, 18, Buckingham-street, Strand, London. (Complete specification.)

7456. **Apparatus for applying electricity to produce water-pressure for fire extinction or like purposes.** Alfred de Brouchere and Lucien Anspach, 28, Southampton-buildings, London.

7465. **Improvements in apparatus for telephone exchanges.** John Edward Kingsbury, 24, Southampton-buildings, London. (The Western Electric Company, United States.) (Complete specification.)

MAY 14.

7473. **Improvements in electric incandescent lamps.** William Brooks Sayers, 71, Norroy-road, Putney, Surrey.

7505. **New or improved safety devices for use with strong tensional electric currents for lessening fire risks.** Albert Lester Taylor, 6, Lord-street, Liverpool.

7511. **An improved brush for dynamos and motors.** Moritz Immisch, 52, Chancery-lane, London.

7513. **Improvements in the manufacture of electrodes for secondary batteries.** William Lloyd Wise, 46, Lincoln's-inn-fields, London. (Paul Schoon, Switzerland.)

7520. **A method of signalling on electric lighting circuits.** Walter Claude Johnson and Samuel Edmund Phillips, 28, Southampton-buildings, London.

7540. **Improvements in electric arc lamps.** William Lloyd Wise, 46, Lincoln's-inn-fields, London. (La Société Japy frères, France.)

MAY 15.

7553. **Improvements in electro-telephonic apparatus.** Ernest Frank Furtado, 65 and 66, Chancery-lane, London.

7560. **Improvements in and connected with ammeters and voltmeters.** Carrington Riddell Gordon Smythe and Ernest Payne, 140, Bath-street, Glasgow.

7572. **Electric sign.** Frank Suter, 276, Strand, London.

7599. **Improvements in electric arc lamps.** Reginald Belfield, 28, Southampton-buildings, London. (Philip Lange, United States.)

MAY 16.

7618. **Improved electrical device for use in dental operations.** John Pitt Bayly, 18, Fulham-place, Paddington, London. (Charles William Manker, United States.)

7624. **Improvements in electrical transformers.** John Augustine Kingdon, 29, Marlborough-hill, London.

7654. **Improvements in electric telephonic apparatus.** Herbert Luzerne Todd, 7, Lincoln's-inn-fields, London.

7670. **Electric meter.** Charles Denton Abel, 28, Southampton-buildings, London. (La Société Anonyme Continentale, France.)

7674. **Improvements in the manufacture of glass shades for electric lamps.** James Augustus Jobling, 24, Southampton-buildings, London.

SPECIFICATIONS PUBLISHED

1889.

6748. **Rotary engines.** Cordenons. 8d.

6867. **Incandescent electric lamps.** Richardson and Hill. 6d.

8453. **Electric currents.** Mordey. 8d.

9166. **Electrical repeater.** Wells. 8d.

9571. **Telephonic communication.** Kingsbury (Welles). 8d.

9723. **Secondary batteries.** The Electrical Power Storage Company, Limited, and Rea. 8d.

10155. **Electric tramcars, &c.** Raworth. 8d.

12135. **Electric cut-outs.** Heys (Chaize and another.) 6d.

13640. **Electric switches.** Thompson. 8d.

18481. **Electric batteries.** Payen. 8d.

20059. **Electrical "cut-outs."** Smythe and Payne. 4d.

1890.

3439. **Secondary batteries.** Currie. 8d.

3717. **Galvanic batteries.** Weigert. 4d.

4533. **Electric circuits.** Lake (The Thomson-Houston International Electric Company). 8d.

4557. **Dynamo-electric machines.** Andersen and Girdlestone. 6d.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Anglo-American Brush	—	2¼
— Pref.	—	1¾
India Rubber, Gutta Percha & Telegraph Co.	10	18
House-to-House	4½	5
Metropolitan Electric Supply	—	5¾
London Electric Supply	5	2½
Swan United	3½	5
Crompton & Co., Pref.	—	5½
National Telephone	5	5¼

NOTES.

Breslau.—The State theatre of Breslau will shortly be lighted electrically.

Austria.—Ziskow, the suburb of Prague, is to be lighted by electricity shortly.

Brunn.—The town of Brünn is to have an alternating current central station.

Gerard Lamps.—A company has been formed in Paris to manufacture Gerard's incandescent lamps.

Long-Distance Telephoning.—From America comes the record, 2,465 miles, for long-distance telephoning.

Lichterfeld.—The electric tram line at Lichterfeld is to be lengthened and equipped upon the American system with overhead wires.

Profits.—We see it stated that it is understood that the American Thomson-Houston Company is making profits to the extent of 3,000,000dols. net a year.

Electrical Insurance.—A Detroit electric light company insures the lives of its employés for £1,000 each, and thus avoids suits for damages in case of accidents.

Paris.—Reports from Paris show that the various electric companies who have obtained concessions for electric lighting are pushing forward their work with great energy.

Watching.—The solicitor to the Paddington Vestry mentioned that it had cost £300 watching the preamble of the Central London Railway Bill through the House of Commons.

Holloway.—A company is being formed for the purpose of taking over the business and electric lighting station of Mr. W. Beale, of Holloway-road, whose premises we mentioned some little time ago.

Electric Seeing.—We see that Edison is reported as busy at work on a far-seeing machine, by which a man in Boston will be enabled to see the face of a friend in New York; this he hopes to have ready for the great exhibition at Chicago in 1892.

Carlsbad.—The town of Carlsbad will be among those lighted only by electric light. The Town Council have arranged for a central station with Messrs. Ganz and Co. for 5,000 lamps. The main streets will be lighted with 50 arc lamps, and 4,000 incandescent lamps will be for use in private houses.

Electric Boats.—The electric launches at Edinburgh seem to be proving a great success. Only 40ft. long, they carry 40 passengers, will go three journeys an hour, often full all journeys, and are earning, on an average, over £1 an hour each at 6d. fares. They run at half-speed at four miles an hour, and taking 23½ amperes of current.

Telegraph Lines in India.—A new telegraph line from Porebunder to Salava has been opened. Postal telegraph offices will shortly be established at Khambalia and Bhauvad. It was contemplated, says the *Indian Engineer*, to construct communication with Dwarka, but the project was abandoned in consequence of opposition by the Baroda Durbar.

Belt Slipping.—If a belt persists in slipping after the machine is fairly under motion, and is sufficiently tight, then it is evident that the pulley is deficient in frictional surface, being either too small in diameter or too narrow face; in either case it is far better economy to change the pulley than to go on purchasing new belts every few months.

Personal.—Mr. Walter F. Jones, late representative of Messrs. Felten and Guilleaume, cable manufacturers, has now joined the staff of Messrs. J. D. F. Andrews and Co., 41, Parliament-street. Mr. Jones has been previously with this firm in Glasgow, and is consequently acquainted with their system of concentric wiring for interiors, which they have made a speciality.

Electric Trams.—Whitsuntide proved a great trial and a great triumph for the Barking-road electric cars. All day long the crowds rode backward and forward, sometimes as many as 92 passengers being carried. No breakdown or mishap occurred, and the electric cars handled the traffic admirably. We are told that one of the cars earned £8 in fares on Whit Monday.

Tesla Motor for Mining.—The Tesla motor is to be introduced in the coal mines of the State of New York. The management of the Shawmut coal mines has just made a contract with the Westinghouse Electric Company for seven of these alternate-current motors and one 30 h.p. generator. The apparatus is to be used in connection with the Hercules mining machine.

Central Electric Railway.—Dr. Hopkinson is of opinion it would take 2,000 h.p. to work the 10 trains proposed to be run on the Central London Railway. The indicated horse-power would be 10 per cent. higher than this, and would require 38 tons of coal a day. It was intended to have an engine at each end of the train, one pushing and one pulling, to avoid waste of time changing ends.

Electric Transmission of Power.—The authorities of Freiburg, Switzerland, have given permission for an electric power station to be opened in October, for distribution to small surrounding industries. From the waterfall there are 300 h.p. available, two-thirds of which will be distributed for running electromotors of ½ to 25 h.p., and the remainder will be used for electric lighting. The price for motive power to customers is 200f. (about £8) per horse-power per annum.

Wire Cutting Tool.—Electric wires about a burning building are dangerous to firemen, both for the reason that they prevent free movement of fire escapes, and also from the fact that if electric light currents happen to be passing there may be danger in cutting with ordinary axes. Mr. J. Knibbs, of Troy, New York, has designed a long-handled tool with a strong insulated lever-handle connected with shear blades on the end of the rod, for cutting wires about a burning building, and it should be useful as part of the equipment of firemen.

Red Tape.—It is stated that the electric lights on the buoys in Gedney's Channel, New York Harbour, will be extinguished shortly to satisfy the eccentricities of American "red tape." The Lighthouse Board has an appropriation for general buoyage service and had a small one for electric lighted buoys. This is now exhausted, and the commissioners are of opinion the general fund may not be legally employed for the maintenance of electric lighted buoys. A similar case is that of an arc light plant in Washington Navy Yard. The department has plenty of money to pay for the plant, but none to pay for working it. The plant therefore has to remain idle till special provision is made.

Electrolytic Production of Zinc and Tin.—M. Burghardt, of Berlin, has patented a method for the preparation of zinc and tin based upon the electrolytic decomsition of alkaline zincate or stannate. The sulphur, antimony, and arsenic are eliminated by roasting, and the mineral is transformed into an oxide, dissolving readily in a bath of hot potash. The two operations are carried out simultaneously by throwing into the alkaline bath a mixture of finely pulverised roasted ore and carbon. The reduction is accomplished and the alkaline salt is formed. When cool the solution is submitted to electrolysis, zinc electrodes being used to obtain zinc and tin or iron electrodes to obtain the tin.

Cellulose.—For some time cellulose has been used in the manufacture of paper, but its extended adoption has been retarded by its high price. Dr. Kellner, director of an Austrian cellulose factory, has, according to the *Elektrotechniches Echo*, succeeded in reducing the cost by the following process: The shredded wool is put into lead-lined boilers with a 5 per cent. solution of common salt, which is electrolysed for three and a half hours. The nascent chlorine bleaches the wool fibre to a snow-white silky substance. The operation is conducted at a temperature of 126deg. to 128deg. C. The process is expected to have an important effect on the trade, as the paper made from cellulose is of particularly fine texture.

Ship Comforts.—The Fairfield Shipbuilding and Engineering Company have launched from their yard at Govan a mail steamer of about 5,000 tons gross, built to the order of the Castle Mail Packets Company, of which Messrs. Donald Currie and Co. are the managing owners. Particular attention has been given to the accommodation for passengers, the ventilation, lighting, and sanitary arrangements being of the most improved and modern character. Lofty 'tween decks, with commodious reception and sleeping apartments, replete with every convenience, are provided. A most complete installation of electric light is fitted throughout the ship. Electric bells are also fitted; and ventilation is assured by means of a system of compressed air distribution.

Current Pie.—

Quoth the waiter,
"What is yours, sir?"
Said the guest,
"I'll have a pie."
Returned the waiter by-and-by;
"Custard, lemon, apple, pumpkin,
Peach or mince, sir, will you try?"
Guest, facetious:
"Give me currant,
Alternating current pie."
Vanished waiter hurriedlye;
Soon returned he with the currant—
Alternating currant pie.
First a currant,
Then a fly,
'Neath the crust alternate lie.
Perished waiter
Horriblye.—*Life*.

Tramways in Scotland.—The proposal to construct cable tramways in Hilltown, Dundee, is now taking practical shape. A local company is being formed with the view of constructing the new line, or leasing it if the Police Commissioners are at the expense of construction. It is proposed that there should be a double line from the foot of Hilltown to the burgh boundary at Fairmuir, a distance of one mile, the estimated cost of the undertaking being from £18,000 to £20,000. A sub-committee has been appointed to visit and report on the cable tramways in other cities before further action is taken. Electrical engineers ought to take special pains that the members of it are made thoroughly acquainted with the advantages of electrical traction, and the fact that in many large towns in America large consignments of cable apparatus are thrown on one side unused, to make way for the improved method of electric tramcars.

Wolverhampton.—The electric light does not progress as fast as it might in Wolverhampton, owing, it is thought, to the fact that the Corporation own the gas works, and derive a good income therefrom, so that they are not in such a hurry to change old lamps for new as other towns who are ridden by "a monopolising gas company." The Wolverhampton Electrical Company, however, wish to wake the public, and have lately taken the steps to do such by exhibiting an immense arc lamp in the Princess-square. This, of course, has hugely delighted the aforesaid public, the gas lights were reduced to flickering glimmers, and people experimented on reading printed type at various hundred yards away. The police, too, were highly in favour of the new illuminant, rightly considering that fewer malefactors will exert their special talents in molestations or undue display if the brilliant rays of the Wolverhampton Company's electric lights shine upon their deeds. It is to be hoped their wishes will be at once fulfilled.

Paddington.—Poor Paddington does not yet seem to be out of the wood. Resolutions almost without number have been submitted and variously carried, rejected, and disallowed by the Board of Trade. On Wednesday another resolution was passed as follows: "That pursuant to the rules of the Board of Trade the Vestry formally consents to the application of the Metropolitan Electric Supply Company, Limited, under the Electric Lighting Acts, for a provisional order for the supply of electricity in the parish, subject to the approval of the Board of Trade." So far it seems straightforward, but it so happens that there are two provisional orders—one prepared by the company and the other by the Vestry. It is to the latter the above resolution was meant to refer, as mentioned in the statement to bring it forward, but it reads—or may equally read—the other way. So the matter is not yet settled, even when it is wished to do so. Curiously enough, the vestry clerk has, we believe, written a book upon electric lighting laws.

Electricity Revolutionised.—The *Indian Engineer* prints in full as received an extraordinary and amusing communication requesting insertion in their next issue. This hails from Mr. T. Lancelott Jones, inventor, writing from Ghorpuri, Poona, tending to show that the only electric machine worthy of the consideration of future scientists has been discovered by the same. The following is the information supplied by the "inventor" himself: "We hear upon the most reliable authority that Mr. T. Lancelott Jones, electrical engineer of Hyderabad, Deccan, has invented an 'electric overbalanced motor wheel and inductive current generator and intensifier,' which, there is every reason to believe, will revolutionise electricity and supply a long-felt want. No animal, pneumatic, hydraulic, steam or chemically produced power is required to cause the wheel to rotate, and therefore we venture to say that no cheaper method of producing electricity can possibly be devised. All power will, in the future, be obtained from electricity."

Hastings.—At the annual general meeting of the Hastings Electric Light Company a 3 per cent. dividend was declared. The chairman alluded to the granting of their provisional order, and expressed his pleasure that the Town Council had at last thought it desirable to have the town lighted by electricity. He considered that at present their company stood second to none of the provincial electric light companies in the country. Alluding to the resignation of Captain Hennah from the office of secretary, the chairman said that like a true captain he had not left the ship until it was in still waters. He thought that in Mr. Burton they would have a most efficient secretary. He had much pleasure in moving the adoption of the report, and the payment of a dividend of 3 per cent. Amongst the many adverse criticisms which they met with was that they had only declared a dividend on paper, but on that occasion that attack could not be made, for they now had the money, and the dividend would be paid at once. The report was adopted unanimously.

Saved by the Telegraph Wires.—So many accounts of death from electric wires come to us from America, that it is quite refreshing to read in the N.Y. *Electrical Review* how telegraph wires saved a man's life. Peter Murphy was working the other week upon the bridge of the New York and Hartford Railway Company over the Connecticut river, at Warehouse Point, Conn., when he stepped on a loose plank, which tilted with him, and he fell off the bridge. The distance to the river is nearly 40ft., and the river bed is full of jagged rocks. About 12ft. below the edge of the bridge are the wires of the Western Union Telegraph Company. Upon these Murphy struck. He had presence of mind enough to stretch his arms, and the wires supported him. He balanced in mid-air until two of his companions crawled down upon some of the lower timbers of the bridge and threw a rope out to him. He tied it about his waist and they hauled him in, and the three made their way to the top of the bridge in safety. Murphy did not receive a scratch.

The Lighting of Paris.—At the last meeting of the Société Internationale des Electriciens M. Hippolyte Fontaine, the president, gave some interesting particulars with regard to the lighting of Paris, and he stated that while, as might be expected, the consumption of tallow for candle making had fallen from 1,200 tons in 1855 to 300 tons last year, the number of candles other than tallow had also declined from 220 burnt per head of the population in 1855 to 190 per head last year. The use of petroleum is rapidly superseding that of vegetable oil for lighting purposes, the consumption of the former being as four gallons to one. The quantity of gas burnt has risen from 105,000,000 cubic metres in 1877 and 152,000,000 in 1883 to 189,000,000, while the applications of the electric light, which did not exceed 22, of 230 h.p., in 1887, had risen to over 500, with 17,400 h.p., last year, this being exclusive of the electric light used in the exhibition. It is estimated that in two years' time, when the central stations are completed in Paris, the total amount of horse-power will have risen to 32,000. Even now the electric light is distributed by 6,800 arc lamps and 118,000 incandescent lamps, while if gas supplies 57·3 per cent. of the total lighting of the city, the electric light shows already a proportion of 18·9 per cent.

Canterbury.—The Canterbury Town Council held a special meeting last week to discuss the electric lighting proposals of the Brush Electrical Company. This proposal comprised 10 arc lamps of 1,200 c.p. in the main streets and open spaces, costing £260 per annum, displacing 43 gas lamps and three Sugg's burners, costing at present £186, so that the cost of lighting would be £74 over the present cost, but giving some twelve times the amount of light. The contract was to be for 21 years, but terminable by either at seven or 14 years. The Electric Lighting Committee presented their report upon this proposal, and thanked the company for the advice and help they had given, but recommended that in the present state of things it would be better not to grant a consent to the Brush Company obtaining a provisional order at this time, but that the Council themselves should at once apply for a provisional order and then treat with the company with a view to, if possible, arranging satisfactory terms by which the company may supply electricity for such public lighting within the area of the city as may, after further consideration of the matter, be deemed expedient, and also for the purpose of private lighting. The report of the committee was adopted, the town clerk explaining that the resolution did not bind the Council to have electricity from the Brush Company. It merely recommended that they should try and make terms. The Mayor said the company would no doubt hear from the Corporation on the subject.

Height of Arc Lamps.—The height of lighting centres for public lighting is the subject of some calculations by M. Kopcke in the *Civil Ingénieur*, where calling a the lighting power of a luminous centre, placed at the height h above the ground, and calling α the angle with the horizon made by the luminous rays falling on a point of the ground situated at the distance z from the foot of the lamppost, the expression of the quantity of light given at this point:

$$y=\frac{a\sin\alpha}{h^2+z^2}=\frac{a\,h}{(h^2+z^2)^{\frac{3}{2}}}$$

and considered as a function h gives for

$$h=\frac{z}{\sqrt{2}},\ y\max = 0{\cdot}3849\,\frac{a}{z^2}.$$

Given two lamps, placed 30 metres from each other, the point least lighted is midway between the two, or 15 metres from the foot of a lamppost, and if for this distance the maximum of light were required at this point the lamps should be placed at the height $h=15\times 0{\cdot}707=10{\cdot}6$ metres, 34ft. At the height of 10ft. above ground they will furnish at the same point about half this maximum. As the practice is often to place them at 12ft. to 16ft., this matter is worth careful consideration. The conclusion drawn is, therefore, that it is far more advantageous to place a less number of strong lamps upon comparatively high posts than to have numerous smaller lamps on low lampposts. In practice, however, the matter is not so mathematically simple as M. Kopcke's formula would seem to show. An arc lamp does not act as a mathematical luminous centre, but distributes its rays in a greater degree at some angles than at others. Strong lamps on high posts are found to give brilliant rings with sombre spaces between, and the necessity for equable lighting in the public streets in practice militates against the use of few very strong lamps on tall posts.

An Electrically Lighted Brougham.—Cheadle, near Stockport, is proud of the distinction of having introduced the first electrically lighted brougham in the North of England. Mr. J. E. Platt, of Bruntwood, Cheadle, has the whole of his residence lighted by electric light, and wishing to go a step further decided to light his brougham in the same brilliant and cleanly manner. He applied to the Manchester Edison-Swan Company, who in turn consulted Mr. G. W. Smith, coachbuilder, of Stockport, and Mr. Platt's brougham is now fitted up electrically, and is pronounced a great success. A battery 15in. long by 6½in.

wide and 9in. deep, fitted up with accumulators sufficient for an eight hours' supply, is fixed inside the box upon which the coachman sits. The brougham has two dress lamps—one at each side—as usual, and the electric current is connected with these by means of the ordinary wires run beneath the upholstery inside the vehicle. The lamps each contain incandescent lights of 5 c.p., and they are constructed so as if the lights should fail to act the lamps can be taken out and candles fixed inside the lamps in the ordinary way. In addition to the outside lights there is an incandescent light fixed in the roof of the carriage at the rear, and this is covered by a coloured globe, and the effect produced is unique and effective. The lamps at each side give an excellent light for the coachman, and the one inside effectually illuminates the interior of the brougham. The whole arrangements of fixing have been very successfully carried out by Mr. Smith, and a satisfactory feature of the construction is the fact that no portion of the fixtures are visible. The lights will be worked by the coachman with comparatively little trouble. The box, in which the battery is placed can be locked up, and the lights are controlled by means of a separate switch for each light. The batteries are charged from the dynamo used for supplying Mr. Platt's house.

Corporation Contracts.—A special form of contract is worthy of notice, recently recommended by the aldermanic committee on fuel and street lights of Holyoke, Massachusetts, as the best for the city to adopt for the future electric lighting of the city streets. In regard to the candle-power of the public arc lights the contract specifies: "The average light of all the lamps of each circuit, considered by itself and independent of all the others, shall constantly, while in operation, equal that of not less than 800 standard sperm candles weighing one-sixth of a pound each, and burning, as near as possible, at the rate of 120 grains of spermaceti per hour. The measurement of the electric light shall be made by comparison, through the use of a Bunsen photometer, with a standard oil or other lamp of at least 20 c.p., ascertained and determined by direct comparison with standard candles of the standard aforesaid. The measurement of the lights shall be made while they are in their regular positions in the street, and with the globes on, and the method of ascertaining the actual candle-power shall be as follows: The light shall be measured in a direction making an angle of 45deg. with and below the horizontal plane of the light; four observations shall be made, each succeeding observation to be from the side of the vertical axis of the lamp 90deg. from that of the preceding observation, and the average of said observations shall be ascertained; successive observations shall be made until 10 such averages are obtained, and the mean of such 10 averages shall be taken in determining the candle-power. The average candle-power of any six lights on any circuit shall be taken to be the average power of all the lights of such circuit, and if on any two nights of any month the candle-power shall be found to be below that called for hereby, the average candle-power for the month for that circuit." Should the actual candle-power be found to be less at any time than that called for, payment is to be made only for the actual candle-power as ascertained, the amount to be paid to be based *pro rata* upon the amount which would be paid were the candle-power equal to that called for. Another clause provides that "the number of lamps on any one circuit shall not exceed the number which the dynamo for such circuit is rated to run, and such dynamo shall not be connected to any other circuit," a clause which is intended, of course, to prevent the running of arc light dynamos in series.

The Thunderstorm at Kibblesworth. — The curious phenomena, such as the stopping of the wire traction rope and continued and varying sparks to men and boys, which recently occurred at the Kibblesworth Colliery, is investigated by Mr. Sydney F. Walker in the *Journal* of the British Society of Mining Students. The cloud, a mass of vapour, charged either by evaporation or friction on the air, has become charged with electricity to some millions of volts; on passing objects these become inductively charged, and on each flash a redistribution of induced charge takes place with flashes. The stoppage of the cars Mr. Walker explains by electrostatic attraction between differently charged bodies, possibly assisted by minute traces of magnetism. Taking the working load of the rope at 40 full tubs and 40 empty ones, and the total rise as 66ft., the average force tending to move the rope will consist of the weight of coal in the full tubs multiplied by half the total rise, and by the rate of doing the work. The weight of the coal would be roughly 40,000lb. This raised through 33ft. in 18 minutes would equal about two actual h.p. Now each tub has four wheels, making 320 wheels in all, leaving out of account the rope and its pulleys. Supposing, therefore, an attraction to be set up between each individual tub wheel and its rail, due to the existence of these electrostatic charges, assisted possibly by minute, very minute, traces of magnetism, it is by no means an impossible contingency that the aggregate holding force should be sufficient to stop the rope. Something of the kind evidently must have been the cause, from the fact that the rope moved on immediately the inducing force was removed. Mr. Walker, in concluding, pays a deserved tribute to the care and exactness of the writer of the original communication, and expresses a wish that other cases should be as accurately observed and recorded; and he specially asked as a personal favour if others having the opportunity would send him details of peculiar phenomena or damage occurring either through lightning or defective electric apparatus. He is making a collection both of reports of occurrences, and of damaged pieces of apparatus, and finds in most cases peculiar phenomena which with study can be traced to their source in explanation of many apparently mysterious phenomena in connection with lightning.

Barnsley.—At the usual monthly meeting of the Barnsley Town Council held last week, the mayor (Alderman Wood) presiding, the electric lighting question was again raised. The minutes of the Lighting Committee reported that the gas company had offered to supply gas to the town for public lighting from June 30 next on condition that the Corporation should purchase the present lamps for £3,000, or by paying £500 a year for seven years, or should rent them at £150 per year. Gas to be supplied at 2s. 10d. per 1,000ft., representing 36s. 10d. per lamp per annum on the present lighting, that the consumption be ascertained by the average meter system, and that the terms be binding for three years from July 1. The committee proposed that the company be offered 36s. 10d. per lamp per annum for 3,250 hours' supply, the Corporation to pay £150 a year for the use of the lamps, to provide for cleaning, etc., and the agreement to be terminable at six months' notice, or as an alternative that the present agreement be continued, but that the Corporation pay 53s. 6d. per lamp per year instead of 48s. 6d. as now. They also recommended that Mr. A. Bromley Holmes, electrical engineer, be appointed to advise the committee on the tenders for elec tric lighting. In connection with the electric light £400 had been spent. The engineer's advice would cost £50, and he would have to be paid two guineas a day when he visited the town. The installation would probably cost £20,000, the tenders which had been received varying from £13,000 to £25,000. Alderman Marsden pointed out that in Bradford they had spent £30,000, and could only supply electricity at 4s. 6d. per 1,000, to which Mr. Haigh replied the electric light was worth 4s. 6d. as against gas at 3s. 4d. per 1,000ft. Alderman Pigott pointed out that expenses had already more than doubled what they were led to expect at the beginning. Where it would ultimately end he could not tell. Alderman Marsden thought at £40,000. Alderman Pigott said the expenditure now spoken of—£20,000—was for the inner area. When they came to light the whole town they would want one or two more lighting stations. In answer to a question, the town clerk stated that the gas company were not bound to supply the Corporation with gas. Alderman Blackburn hoped the gas company would accept their proposals. A very long discussion followed as to the probable expense which would have to be incurred in providing the electric light in the borough, and eventually the minutes were passed, and it is understood the committee will wait upon the gas directors and lay their new proposal before them.

Design of Armatures.—The following abstract of a paper, by A. Isenthal, from the *Electrotechnische Zeitschrift*, appears in the *Proceedings* of the Institution of Civil Engineers over the initials "G. K.": In this article the author has attempted to establish general rules for the design of armatures when the current, C, terminal pressure, V, and speed in revolutions per minute, n, are given. The rules are based partly on theoretical considerations, and partly on the present practice followed by leading dynamo makers, and have been established for three distinct types of machines, viz., the disc, the cylinder, and the drum. By investigating the performance of 15 disc machines, the author finds that the average strength of the field is 4,500 in C.G.S. measure, and that 2·4 metres (nearly 8ft.) of armature conductor are required for every volt terminal pressure. The mean circumferential speed of armature is assumed at 4,000ft. per minute. The resistance of the armature is $0{\cdot}08\,\frac{V}{C}$, and the density of current in the armature conductors is 2,500 amperes per square inch. The author assumes that the weight of core iron in a disc armature is 15·7lb. per kilowatt output, and that the radial depth of the core is 2·5 times its thickness. From this he finds that the radial depth in inches can be given as a function of speed and output according to the expression $0{\cdot}00243\sqrt{C\,V\,n}$. For cylinder armatures the author asumes a circumferential speed of 2,360ft. per minute, and a density of 2,500 amperes per square inch in the armature conductors. The strength of field in machines for moderate pressure is 2,500, and in machines for very low pressure (plating machines) it is 1,000. One volt terminal pressure is in these two cases produced with 4·5 and 11·2 feet of armature conductor respectively. The resistance of armature in machines for moderate pressure is given as $0{\cdot}0455\,\frac{V}{C}$. The weight of core iron is assumed to amount to 22·5lb. per kilowatt. Similar determinations are made for drum machines. The strength of field is given as 4,000 for moderate and 1,800 for low-pressure machines. Circumferential speed and current density are assumed to be the same as in the cylinder machines. The length of armature conductor to produce 1 volt terminal pressure is 2·8ft. and 6·3ft. accordingly, as the machine is one of moderate or low voltage, and the armature resistance is $0{\cdot}0287\,\frac{V}{C}$ and $0{\cdot}0645\,\frac{V}{C}$ respectively. The weight of iron in the armature core is 27lb per kilowatt. Rules are also given for the number of layers of armature wire, depth of winding, number of coils on armature, dimensions of commutator spindle, and pulley, and output per lb. of copper of armature conductor.

Fitting up Laboratories.—There is very little question that a large amount of technical instruction in electrical and kindred sciences is now being contemplated, and wisely contemplated, throughout England. Considerable sums of money are being expended for the buildings, and proportionate sums are to be laid out upon properly fitting out these scientific laboratories with instruments and apparatus. In the same way that those in authority would deprecate the spending of large amounts upon exterior decoration of the building rather than on convenience, and the proper laying out of rooms, there is a question which must be faced at the outset in the purchase of apparatus. Oftentimes there is a certain specific sum granted which must be spent in the best way possible. This money may be spent in three ways—in buying the best finished and most costly instruments; in buying the cheaper class of instruments—mostly coming from Germany, highly finished in appearance but not too accurate scientifically; or what is by far the best when the expenditure is limited, instruments may be obtained, finished in the best possible way with the most scientific accuracy desirable, in those parts where it is necessary, but where the cases, the legs, the various mechanical fittings are, though properly made and plainly finished, yet without that superfine polish and painstaking squaring, facing and lacquering which sometimes almost double the price of apparatus. We have seen some apparatus constructed by that brilliant experimenter, Mr. C. V. Boys, F.R.S., which were the acme of desirability from this point of view. At every part where accuracy of movement was required, or delicacy and freedom of revolution necessary, jewelled points, case-hardened steel points and beautifully finished parts worked to perfection; but the inessential parts were left rough, or at best squared up and painted. For laboratory, student, or testing work these were all that could be desired, and in many cases might be employed where payment for costlier instruments has restricted the amount of apparatus obtainable. Mr. Niblett, of Messrs. Pitkin and Niblett, Clerkenwell, the ingenious inventor of the gas escape detector, which received such encomiums at the Royal Society's meeting, is also a believer in this class of apparatus. We have had our attention drawn to reflecting galvanometers in a simple improved form in which the principle of best essentials and plain nonessentials is carried out; and the same with the tangent galvanometer wound for current and potential, variable resistances, and other apparatus destined for laboratory use. No doubt scientific instrument makers would lay themselves out and supply such instruments if there were the demand, and when scientific laboratories are springing up over the country, we think the professors, teachers, and demonstrators who hereafter may have to carry on work therein may thank us for drawing attention to a point which possibly

have the direction at the outset may be

THE EDINBURGH EXHIBITION.—IV.

At Stand No. 28, in the Machinery Hall, Messrs. Carrick and Ritchie, hydraulic engineers, Edinburgh, show what can be done in the way of applying water power to the production of electricity, both for lighting and for the transmission of power, by means of turbines and other water motors.

They show one of their horizontal Waverley turbines, combined with a dynamo, made by Elwell-Parker, of Wolverhampton. This machine is specially constructed for lighting country mansions, factories, etc., wherever there is a stream of water of moderate size in the neighbourhood. It is suitable for charging accumulators, in which case a small stream driving the apparatus during the day is sufficient to light up a large house at night.

Messrs. Carrick and Ritchie have supplied the water power to a number of installations in various parts of the country. Various forms of the Waverley turbine are shown for different heights of fall. The great superiority of water as a perfectly steady driving power for electric lighting machinery over any other is not to be overlooked, and the fact that many of our streams flow from their source to the sea without being made to give up any useful work on their way thither augurs well for a large application of this hitherto much-neglected power.

In order to show what can be done by applying the water supply of a town to produce power, a small jet motor is fixed to drive a dynamo for electric lighting. The water after being used in the motor is returned to a large tank and used for feeding the boilers, and is thus not lost. The water is taken from the main pipe in the exhibition, where there is a pressure of about 50lb. to the square inch. In view of an increased water supply to Edinburgh, this machine is a highly interesting one. There is hardly any purpose requiring a small motive power from $\frac{1}{10}$th to 1 h.p. to which it may not be applied. It has two jets, both of which can be used when all the power is required, and only one when less than the full power is wanted; by this means the water is allowed to pass into the machine with the full pressure in the pipe due to the head.

It might be argued that it would be expensive to run this machine and pay for the water, but Messrs. Carrick and Ritchie propose that all the water passing through the machine be sent into the cistern of the house for supplying the boilers, bathrooms, etc. There are no parts where oil would come in contact with the water, and it would in no way be polluted to debar it from being used for drinking purposes.

The exhibits of the Electric Construction Corporation (68) comprise a great variety of plant for all purposes, including lighting (both on the alternating and the direct systems), all kinds of plant for isolated installations for business places, private or public buildings; also plant for transmission of power, propulsion of tramcars, lifts, launches, etc. Special mention need be made only of the following:

A self-contained electric tramcar, capable of seating 40 passengers. It is fitted with storage batteries and propulsion gear consisting of electric motors and gear to couple same to axles; also switch for starting and stopping, and for regulating the speed of the car. This tramcar is suitable for running on any line of suitable gauge, without any preparation or attention to the permanent way.

King's automatic distribution gear regulates automatically that the batteries in every storage station should be charged in two halves, and is arranged to automatically change over to the second half when the first half has been fully charged.

There is shown a 100-kilowatt combined alternating dynamo and engine, complete and in working order, and capable of developing 100 amperes at 1,000 volts. It lights the lamps fixed round the stand, and also those forming the name of the corporation, by means of 12 Parker transformers, which transform the E.M.F. of 1,000 volts to that of 100 volts.

A type of the single motor equipment on the "Sprague system" is shown. The gear is carried by the axle, and the other end is supported by springs from the car body. A perfectly steady suspension is thus obtained, and vibration and jolting of the wheel base running on the track does not affect the motor and its gearing. This system, with further accessories, making it very complete and distinct by itself, has, we understand, been very largely adopted in all sizes of cars, in single and double types, in the United States, and is giving entire satisfaction.

Two continuous-current dynamos for exciting the field-magnets of the alternator, for charging accumulators, and for driving two motors on the neighbouring stand of Messrs. Singer and Co., as well as various types of secondary batteries, are shown.

There are also shown two types of distribution switchboards; an automatic "make and break" switch, for use with accumulators; direct reading ampere-meters and voltmeters; and other accessory instruments for installations in which accumulators are used.

As mentioned in our last article, Messrs. Woodhouse and Rawson have designed and carried out the lighting of the bandstand, one of the prettiest lighting exhibits in the exhibition. It is lit in rather a unique manner. In the centre of the sounding board is placed a Trotter diffuser with three lamps, and from this there are radial lines of 8-c.p. lamps, frosted in coloured shades. Around the edge of the bandstand are rows of small lamps, while over the steps are placed in cut glass fittings two high candle-power lamps. Outside the stand on top are eight incandescent lamps of 100 c.p. hanging from brackets and enclosed in cut glass fittings. Lower down are eight spikes, which are illuminated at their points by smaller lamps. The current is supplied from a dynamo of Elwell-Parker type, situated in the Dynamo Court, by means of a pair of underground lead-covered mains. This dynamo also supplies the stall of Messrs. Woodhouse and Rawson (47), on which are the following exhibits:

Scott's flash signalling lantern, which is the invention of Commander Percy Scott, R.N., and the work in connection with which has been entrusted to Messrs. Woodhouse and Rawson, has been designed with a view to enable flash signals to be sent on the Morse system with greater rapidity than has heretofore been possible, and from a point where the present mechanical arrangement of shutter could not well be employed.

The lamp is surrounded by a number of vertical shutters pivotted above and below, and engaging by means of short arms or toothed wheels with a central wheel. The motion of the latter is produced by an electromagnet acting against the force of springs; when the magnet is energised a rapid but short movement of the wheel takes place, opening the shutter for a longer or shorter period as desired, and produces thereby longer or shorter flashes of light. The action of the springs carries the wheel back to its original position as soon as the current is broken in the electromagnet. The electrical circuits are arranged in a special manner with the view of avoiding running the lamp at full incandescence during such time as the shutters are closed, and consequently the light is obscured. The magnet coils are, therefore, put in circuit with the lamp, the resistance of the former acting so as to dull the incandescence, but only to such a point as will allow the thick filament, necessary for the 100-c.p. lamp employed, to be raised to its full incandescence during the period of the shortest flash which may be found possible to use in practical working.

In order to further reduce the strain put upon the lamp by the heat developed during continuous running a special switch is employed in connection with the above lantern. The handle of the switch is hinged in such a way that under normal conditions a strong spring is pulled upon the end of it and breaks the main circuit to the lantern.

In order to commence signalling it is necessary to pull down the handle against the force of the spring. This completes the circuit to the lantern, and a further depression similarly to the telegraph key operates the shutters. The contacts are so arranged that in the act of opening the shutters the lamp and magnet circuits are momentarily in shunt to one another, and as the E.M.F. absorbed by the magnet coils is only eight volts the amount of sparking during signalling is very small. Extra contacts are attached to the switch to enable a Morse instrument to be added, whereby the signals may be automatically recorded in the same way as in telegraphy. The action of the lantern is very satisfactory, and one of the original type has been in work for several months on board H.M.S. "Northumberland."

It is hoped that by means of this lantern it may be possible to attain to such speed in flash signalling that the two parties may be able to interpret each other's signals, which at present, owing to the different rates at which the signals are sent, is found to be very difficult.

Horn's electric tachometer is designed for indicating directly the speed of a rotatory shaft. The action of this is founded upon Arago's discovery of the currents set up in a copper disc when rotating in a magnetic field. The disposition of the instrument is such that its calibration is not affected by a variation in the strength of the permanent magnet employed, while its sensitiveness is superior to any form of centrifugal speed indicator. It is specially useful for marine and railway purposes, where it is subject to shocks, which have practically no effect upon it. Its sensitiveness enables it to be specially useful in detecting slipping belts, which are a fertile source of loss of power in mills, etc.

The Barber-Starkey automatic accumulator cut-out, the invention of J. W. S. Barber-Starkey, Esq., is likely to have a large application in all installations where accumulators are employed.

It is devised to automatically switch in the charging circuit of accumulators as soon as the E.M.F. of the dynamo has reached a predetermined point, and to break the circuit again as soon as the E.M.F. has fallen to any desired point. Its action depends upon the movement of the armature of an electromotor, which is joined in shunt upon the terminals of the dynamo. The movement of this armature can be arranged to take place at any required E.M.F., first by the movement of a weight which acts against the electromagnetic attraction, secondly, by the position of the armature with respect to the motor field when it is at rest. At the end of an arm, joined to the armature on the opposite side of the weight, are two prongs, which, when the movement of the armature takes place, dip into two mercury cups, thereby completing the circuit from the dynamo to the accumulators. When no current is coming from the dynamo the weight causes these prongs to lie clear of the mercury cups. When the dynamo has reached a certain E.M.F. the attraction of the armature is sufficient to counterbalance the weight, and any slight movement causes it to move into a stronger field. The movement, therefore, which makes the circuit is a quick one. We will suppose that it is arranged to make circuit as soon as the E.M.F. has risen to 115 volts. The charging E.M.F. for, say, 52 cells will be considerably higher than this, and the pull of the armature will be sufficient to keep the prongs depressed in the mercury against the action of a small spring acting at their end of the arm. If we suppose the E.M.F. to drop to, say, 106 volts, the spring has sufficient force to raise the prongs slightly; the armature then being turned into a weaker field is enabled to overcome the force of the weight, and a quick movement of the prongs out of the mercury is ensured. By properly adjusting the position of the weight and the angle of the armature with regard to the magnet poles when the circuit is broken, the instrument can be made to act over such a range as will cover all necessities for installations where accumulators have to be charged. The power absorbed by the instrument is small, and by a proper proportion of the size of prongs used it can be used for any desired current, and in this respect appears superior to any solenoidal form of instrument devised to do the same work.

The great difficulty hitherto experienced in securing a sufficiently quick break appears to have been successfully overcome. The instrument has been put into the hands of Messrs. Woodhouse and Rawson United, Limited, who will no doubt secure for it the popularity which it certainly deserves.

Messrs. Woodhouse and Rawson United, Limited, also show several specimens of new insulating material suitable for the bases of switches and other work requiring high insulating properties coupled with uninflammability. This new substance can be moulded accurately to any desired form, and metal parts can be firmly embedded in it during the process of moulding. As the main constituent employed is Portland cement it naturally is not of so expensive a nature as any of the substitutes for slate. It is waterproof, and possesses enormously high insulating properties. Included in this company's general exhibit are a large variety of instruments, such as voltmeters, ammeters, rheostats, arc lamps, miners' portable lamps, wire-testing apparatus, and railway telegraph instruments, and in addition to which there is a show of bells of every possible size, probably the most complete yet made, and one large bell being utilised by the exhibition authorities for automatically striking the hours and tolling continuously for some minutes at the hour of closing.

Naturally a large amount of space is devoted to switches and cut-outs, which form the principal specialities of the company, and of which they claim to be the largest manufacturers in the world.

We have already given a short description and illustrations of several of their leading types in these columns, but would draw the special attention of our readers to the new type Diamond switches for large currents, several of which are shown on the stand. The workmanship and finish throughout are of first-class quality, all parts being carefully made to standard gauges, and every instrument being thoroughly tested before leaving the works. The principal types made by the company are the B. W., which are a small single-light switch for use with brackets and electroliers, the G. and "Diamond" quick break switches for single lamps and groups, and the F. I. switches for accumulators, etc. The Cunningham and Woodhouse and Rawson magnetic cut-out is also on view, and we understand that the sale of this well-known instrument is even larger than before, the many years it has been on the market having only added more convincing proof of the excellence of the design. We would strongly recommend our readers to give more than a passing glance at the contents of the stall in general.

LIGHTNING-GUARDS FOR TELEGRAPHIC PURPOSES.*

BY DR. OLIVER LODGE, F.R.S., MEMBER.

(Continued from page 411.)

But while so carefully contemplating the protection of the cable, why not protect its instruments as well?—for a syphon recorder and an artificial cable are no cheap toys. It can be done perfectly well. Put them all inside the sheath of the cable and they are safe. Of course the sheath of the cable must be enlarged to receive them, but that is easy enough. Use a metal house, and at the point where the cable enters it attach thoroughly its sheathing wires to the house, making a good joint all round, and the thing is done. The cable station is now an expansion of the sheathing, and everything inside it is perfectly safe.

It may be objected that a metal house in hot climates would be a nuisance. Very likely; there may be sufficient practical objections to the plan, but that is for others to judge. However, continuous sheet metal is unnecessary. Wire gauze, even with meshes so large as is used for poultry yards, may serve sufficiently well, if a few stout wires be added to make effective contact with the cable sheathing.

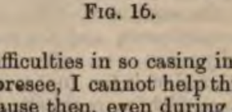

Fig. 16.

Unless practical difficulties in so casing in a cable station are greater than any I foresee, I cannot help thinking that it would be worth while; because then, even during a thunderstorm, the operators might continue signalling in undisturbed security, instead of having to suspend operations, disconnect the instrument, and short-circuit the cable to its sheath. Slow trails of disturbing current might indeed render signalling difficult or even impossible, but there would be no danger.

Reliance is commonly placed on the short-circuit of cable and sheath. If the short-circuit is very short indeed the reliance is fairly justified, but if it be effected by a loop of any size (Fig. 16) then there is no absolute security, for a flash striking at A will bifurcate, and part of it rush into the cable. It may be said that that will not matter, because another part of it will be travelling down the outside, and that hence the G.P. between the two pulses (the internal and the external) will not be strained. But there is no guarantee that they will travel at the same rate. There is, indeed, every certainty that they will not. The outside pulse, moreover, will soon dissipate itself by leakage into sea water, leaving the internal one to work its way out through any weak place it can find. Several hundred volts is a very insignificant potential for such a pulse, but it is not customary to apply several hundred volts to a cable with equanimity.

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* "On Lightning-Guards for Telegraphic Purposes, and on the Protection of Cables from Lightning, with Observations on the Effect of Conducting Enclosures." Paper read before the Institution of Electrical Engineers, April 24th, 1890.

But if instead of a mere loop we put a thimble or hollow metal vessel over the end of the cable, connecting its sheathing to the walls, and connecting its core to the interior, then no sudden splashes can enter the cable at all; they will keep to the outside and do no harm (Fig. 17).

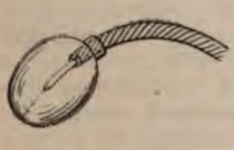

FIG. 17.

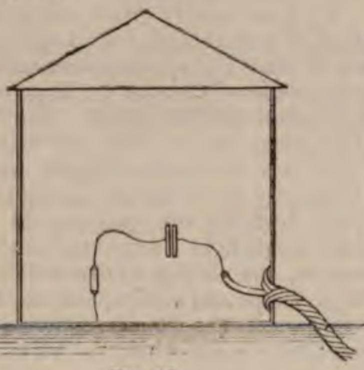

FIG. 18.

Such a magnified thimble is the proposed metallic or wire-netted cable station; and it is one that has the advantage of never needing to be removed; one which contains instruments and operators, and protects them all alike from dangerous disturbances (Fig. 18).

It may be asked whether such a house should depend for its earth entirely on the cable sheathing, or whether a local earth should be provided.

It is not a vital point, but a local earth is to be recommended in order that even the outer sheath of the cable shall not have to carry flashes of exceptional violence, which might unduly heat it. Extra earthing the house can do no harm, and may thus occasionally do good. But do not think of sending out to any local earth a wire from the earth terminal of the recorder or any testing instrument inside. The inside of the metal house is their appropriate earth, and no other must be permitted. Again, gas-pipes, water-pipes, and everything else may be permitted to enter the house, but only on the strict condition that they be effectively united to it at their point of entering—not at some other point. Connecting them or anything else to the house by a mere wire is not a bit of good. The cable, the gas-pipes, and every other conductor which penetrate the walls of the house must be at that place united to those walls. I have ample experimental as well as theoretical grounds for this assertion. No insulated conductor must be allowed to protrude, unless it be enclosed in a metallic sheath connected to the walls, with the distant end of this sheath itself closed. Such an insulated conductor is, of course, the core of the cable itself; the completing closed sheathing being the distant cable station. If that be a mere wooden shanty, disturbances may there enter the cable, and not only do it damage, but derange the signalling power of your instruments at this end also; all your fine protection being no good if not imitated at the far end of the cable.

Since no insulated conductor must on this plan be allowed to penetrate the walls, it is manifest that no land line can be permitted to enter a cable station. The land signalling station must be a separate chamber. It need not be a distinct building; it may be under the same roof, but it must be wire-fenced off from the cable compartment, and the messages must be put through non-electrically.

Whether such a separation is too inconvenient to be contemplated, I leave to those with more practical knowledge to say. I am only pointing out what is necessary for absolute protection. Of course a reasonable amount of protection can be obtained under less stringent conditions, and I am by no means laying down the law as to what ought to be done in practice; all I say is that unless all this is done the protection will not be absolute. Practical men are far the best judges of questions relating to temporising and expediency. For instance, windows and doors are necessary in a cable station, and although they may be fenced over with wire netting, it is not to be supposed that in all conditions of practice they will never be left open, or that there will never be a break or a serious imperfection in the continuity of the metallic sheathing to the house; and in face of the *liability to such* accidents, it is not to be supposed that proper lightning-guards can be dispensed with. They will, however, then become the last citadel of security, and not, as at present, the outer line of defence.

It is customary, I believe, to land the ends of cables in a cable hut on the beach, so as to be able to get testing instruments as close as possible to the real thing, undisturbed by insignificant shore leads. There is not the slightest difficulty or danger introduced by this practice, provided the hut or an enclosure inside it is made of iron, and both cable and shore lead are well connected to its walls by their outer sheathing as they enter it. Testing instruments and all inside the enclosure are then perfectly safe, except from disturbances conducted in through the central core of the lead, and this can only happen when there is some great defect at the cable station. It is this lead from hut to station which now represents the cable, and all the care described as proper to be taken of the cable must, of course, be taken of it.

The cable hut need not be itself of iron. If it contains an iron box, as shown in Fig. 19, all requirements will be satisfied, and such a plan may, perhaps, be convenient. The lid can be removed for occasional testing without appreciable risk. In case a trace of disturbance should by chance get into the lead, a lightning switch may, for a final appeal, be included in the box.

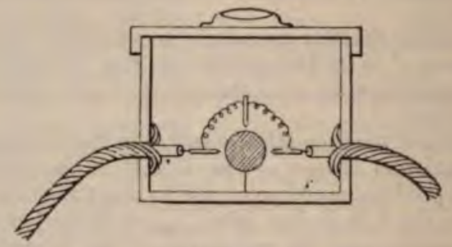

FIG. 19.

I said above that there were cases when the dichotomised pattern of Fig. 11 was sufficient. This is one of them. There is not the slightest objection to a single terminal here, connected with the inside of the box, because nothing violent can splash up into it.

The box may advantageously have some rude local earth of its own, merely in case its hut should happen to receive a direct flash of lightning.

Experiment No. 12.

To demonstrate the protecting action of cages, I put a parrot cage over a thin-wire reflecting galvanometer standing on a copper plate through which a lead-sheathed cable passes, the lead being attached to the copper where it passes through the hole by a number of soldered wires. If this junction is defective the experiment is liable to fail—*i.e.*, the protection will not be thorough. The cage also should be well connected with the copper plate. The terminals of the galvanometer are connected, one to the inside of the cage at any point whatever, the other to the core of the cable. The distant end of the cable may be similarly treated, or for simplicity its core may be directly connected to its sheathing, and a tight-fitting metal thimble or hat put over it. Before doing this, however, I apply something representing a signalling E.M.F. to the distant end, to show the sensitiveness of the caged galvanometer—*e.g.*, touching the core and its sheath simultaneously with a pair of wet fingers immediately drives the spot of light off the scale.

All being properly arranged, flashes are sent from a jar to any point of the cable—to its far end, or to the cage of the galvanometer, etc.—some other point of the cable or cage being earthed. Not a wink does the needle show, at any rate to cursory inspection; and if a safety valve be supplied, no matter with how microscopic a spark gap, it cannot be made to overflow.

But all the time these flashes are going on an operator in the distant cage may be sending voltaic currents along the cable and signalling to the sensitive galvanometer inside the cage without any disturbance from the violent rushes outside.

It is not to be supposed that such cable houses afford any protection against earth currents, or any other steady or slowly varying effects. These will produce their full effect quite careless of the fact of metallic enclosure. Nothing but a perfectly conducting screen can entirely protect against them, and that is not a likely invention. Atmospheric disturbances also, and even discharges, in so far as they are slow or leave subsiding effects behind them, will be felt by the galvanometer; but then, although inconvenient to a reader of signals, slow disturbances are not dangerous. It is the violent and sudden rushes that are dangerous, and these are wholly excluded, occurring only in the outer metallic sheath. To exclude steady currents of too great strength a short length of very fine wire must be included in the circuit.

Experiment No. 13.

To emphasise the fact that the galvanometer is not in the smallest degree protected from steady currents, except in so far as the resistance of core and bobbin bears a large ratio to the resistance of sheath and cage, according to rudimentary laws of divided circuits, I take the terminals of a single storage cell and touch them to two points of the outer sheath of the cable an inch apart, like A B (Fig. 20). Instantly the spot of light is flung off the scale. Applying the terminals to points $\frac{1}{8}$in. apart only, the needle is still strongly disturbed, and, indeed, it is only by very careful feeling about and adjusting within the hundredth of an inch on the same sectional circumference of the cell sheath that a neutral position for the second terminal can be found, and the galvanometer cease to tap off any fraction of the current.

Diagrammatically, the arrangement is this:

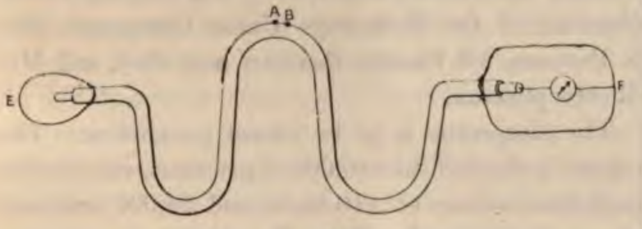

Fig. 20.

With the terminals at A B, the galvanometer plainly receives a minute branch current, unless A B are coincident.

The simplest way to realise the matter is to recognise that when a current is passing in the sheath from A to B all the left-hand portion of the cable is at A potential, and all the right-hand portion is at B potential; hence, of course, there is a tendency to leak along any available path between the two portions; and the core is such a path.

But Leyden-jar flashes may be sent not merely to points close together like A and B, but to points as far apart as you please, like E and F, and the galvanometer shall show nothing.

But now arises a very interesting question. The protection thus illustrated, is it theoretically perfect, or only perfect enough for all practical purposes? Does a metal cage protect a galvanometer absolutely from these sudden disturbances?

Put it in another way. Everybody knows Faraday's cage, or metal-lined room, into which he went with electroscopes, birds, frogs, and other instruments, arranged that the outside should receive violent flashes, and detected nothing inside. Suppose he had added to his stock a galvanometer, connecting its terminals to two points of the walls, would he have got anything then? It naturally occurs to ask, Why did he not try it? What would he have expected the result to be? Did he perhaps not try it because he felt already sure of the result? If so, the feeling of certainty was premature. Whether his guess might happen to turn out right or no, he certainly had not all the facts before him on which to base an opinion.

Let us go into the question. First of all, Mr. Chattock and I obtained the following result a year or two ago—viz., that between two wires wholly inside a wire-gauze house not a trace of spark can be obtained, whatever flashes pass along the outside. The only way we got sparks inside a metal enclosure was by allowing one of the wires to protrude a little through a hole in the walls without touching the sides of the hole.

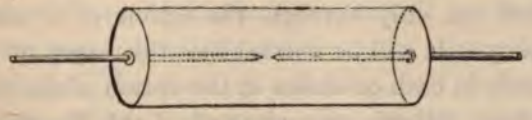

Fig. 21.

Thus, for instance, Fig. 21 gives no sparks inside, but Fig. 22 may give some very small ones.

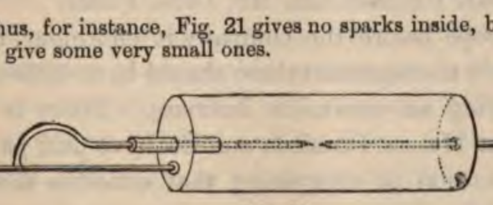

Fig. 22.

But this last is hardly a fair device: it is equivalent to turning a portion of the enclosure inside out; the protruding wire should be a part of the interior surface. Inside a thorough and fair metal enclosure sparks cannot be got between its walls.

Recently Hertz tried what is practically the same experiment, his object being to demonstrate that rapidly varying currents traverse only the outside of a conductor (*Phil. Mag.*, August, 1889). He took a sort of mouse mill of wires (Fig. 23), and, inserting it in a place where sparks would naturally occur between the axial wires, he found it not possible to obtain any until many ribs of the mouse mill had been removed so as to leave a great gap for the penetration of electromagnetic waves, or unless he coated the glass tube portion of his enclosure with only a film of silver so thin as to become incipiently transparent to such waves—*i.e.*, transparent to light. All this shows clearly why a cage protects a cable. No sparks are possible inside, and therefore its insulation cannot get damaged.

But what about a galvanometer or telegraph instrument?—*i.e.*, what about the conduction test? Insulation is safe enough, but will the signalling be interfered with during the continuance of a storm?

Well, if we try the experiment by putting a galvanometer inside a good conducting vessel and attaching its terminals to the walls, a small patch of gauze being, of course, provided for the ray of light to get in and out, nothing will be seen when ordinary flashes are given to the cage, and that must certainly have been the result of the experiment if it had been tried in Faraday's time with the galvanometers of that day.

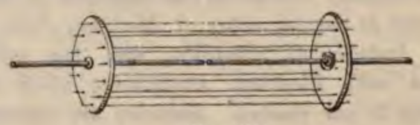

Fig. 23.

But a galvanometer is in this arrangement so severely handicapped by short-circuiting that it is perhaps unfair; so modify it by using an elongated form of enclosure and attaching a low-resistance galvanometer to points of it a good distance apart. The metallic sheathing of a cable is such an elongated enclosure; hence modify the simple cage experiment thus:

Experiment No. 14.

Instead of the thin-wire galvanometer, which we find easy to protect, encage a thick-wire galvanometer, and join it up to the lead-covered cable as already described, with good connection between cage and sheath. Sheathe also the distant end, and connect up as in Fig. 20. Now send flashes to E or to F, or to both; or spark to E, and let F be earthed, or *vice versâ.* The galvanometer gives a slight kick at every flash. Its safety valve shows nothing, but a feeble pulse does pass round its wire.

When I first got this effect, the cage employed was a common parrot cage; but, since its wire junctions could not be depended on, I had one made of fine copper gauze, soldered to a disc of copper at top and to a flat ring at bottom, suitable for clamping down to a copper plate. The same disturbance being still found when it was used, a solid sheet-copper watertight hat was next made and soldered down to the plate, the gauze cage being placed over it as a supplemental and outer covering. Still the residual effect remained, apparently unaltered in strength.

The protection of a galvanometer from these sudden discharges is therefore not theoretically complete. No amount of covering in can absolutely eliminate all disturbance. No matter how sudden a pulse may be, so long as there is an integral passage of electricity in one direction along a conductor, the central portions of that conductor will convey some trace of it. The integral passage of electricity along the axial wire is, in fact, that determined simply by its relative conductivity as compared with its surrounding sheath, irrespective of more complicated considerations. But whereas in the outermost layer of the sheath there are violent surgings, the current-strength being very great and alternating, nothing of the sort occurs in the central portions; the violence is all damped out, and there remains nothing there but a quiet and sluggish flow. The rush in the outer layer of a conductor induces currents in the layer next below, these again in the layer below that, and so on; a sort of diffusion of currents occurring towards the axis, like the diffusion of heat in a body to whose surface heat, or an alternation of heat and cold, has been suddenly applied. Such diffusion is accompanied by a flattening out of the waves, a decay of all their suddenness, so that the axial disturbance is a mere peaceful flow, analogous to that given by a voltaic cell, not having a trace of jump left in it. The very smallest breach of continuity stops it altogether; it is impossible to get a spark in the axial wire; but if this wire be a completed conductor it takes its share of integral current along with the rest. Not simultaneously, however; this diffusion inwards occupies time, but the delay has no particular effect to call for notice here.

Another way of putting the matter is to use the mechanical analogue of slipping wheelwork as representative of a conductor. Then, if the outer layer of wheels be spun to and fro violently, and left with a certain residual spin to represent the impact of electromagnetic waves from the dielectric on the metal, that residual spin will penetrate to all parts of the geared mechanism, except where there is absolutely perfect slip—*i.e.*, except into space bounded by a perfect conductor.

(To be concluded.)

THE

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Specimen copies of the paper will be sent on request.

ELECTRIC TRACTION.

We are glad to see that a decided attempt has been made to introduce, with greater energy, all forms of electric traction. A company has been formed with a capital of £350,000 to purchase the works of Messrs. Immisch and Co. and the Electric Traction Company, for which £242,000 has to be paid in cash or ordinary shares at the discretion of the directors. The board is an extremely strong one, consisting as it does of Lord Bury, Lord Egerton of Tatton, Mr. James Pender, J.P., Mr. Thomas Fuller (director of the Tramways Union Company), Mr. J. Paxman (of Davey, Paxman, and Co.), and Mr. R. Macpherson.

The prospectus is to be issued to-morrow. The capital is divided into 10,000 7 per cent. cumulative preference shares of £10 each, and 25,000 ordinary shares of £10 each. The whole of the preference capital will be devoted to working capital for the development of the business, and the shares are entitled to a cumulative preferential dividend of 7 per cent., and to a contingent rateable division of profits with the ordinary shares after payment to the latter of a non-cumulative dividend of 10 per cent., and they are also entitled to priority in repayment of capital. These, therefore, are specially safe-guarded, making them almost equal to debentures. The company acquire the works of Messrs. Immisch and Co., together with the fleet of electric launches, which is already developing into an exceedingly good paying branch of electric traction, and promises to develop far faster than at first thought of, and they also acquire the business and goodwill of the Electric Traction Company with the Barking-road plant. No doubt the price seems large; it must be remembered, however, that these companies have done an immense amount of work, which now enables electric traction to be regarded as a mechanical and commercial success; that it is for them to reap the benefit; and that this can be done in England at the present time, as has been pointed out, only through the action of a strong company. It will be noticed that the payment will be made in cash or shares at the option of the three directors, hitherto unconnected, Lord Egerton of Tatton, Mr. Paxman, and Mr. Thos. Fuller.

The scope before the company is enormous, and under good management there should be no difficulty in obtaining an enormous business. There is no doubt that Messrs. Immisch and Co. have paid particular attention to everything that concerns motor work, and have done more than any other firm to bring the subject prominently before the purchasing community. They have been eminently successful in their colliery work, and, in fact, generally their motor work, and we trust that the new company will reap the benefit, the foundation of which has been so admirably laid. When we consider the enormous amount of work which has been done in America, and the comparatively little that has been done in England and her colonies, we see the scope for such a company as this, and it may be taken for granted that the board of directors we have named would not lend themselves to any business which did not show an exceedingly good prospect of a great success.

A SUGGESTION.

Most people who preach a sermon have a text, which forms the basis of their discourse. The text we desire to discuss is that hundreds of eager minds and deft fingers are working in directions that either have been fully explored before, or that lead to no goal. Last year the Institution of Electrical Engineers paid a visit to the Paris Exhibition, and the opportunity was taken to read and discuss papers. This year we have the Edinburgh Exhibition, an exhibition held in the most picturesquely situated town known to the world, an exhibition sufficiently electrical to warrant the warmest support of the Institution. It is understood that the members of the Institution will pay their official visit in the month of July, when a most cordial welcome will undoubtedly be given to all who can attend. Our suggestion amounts to this, that some gentleman should be invited by the exhibition authorities to provide an exhaustive paper, indicating the salient electrical problems that are awaiting solution in practical telegraphy, telephony, lighting, and transmission of power. Given a monograph upon the faults of the telegraph, and no doubt ere long these faults will be remedied, and so with the other practical branches mentioned. The telegraph authorities probably get every week a number of inventors bringing inventions that have been tried and rejected a hundred times before. The men who have spent time and money in perfecting some detail can hardly be got to believe that the work has been done before, and many of them think if they do not say, while many of them say as well as think, that the authorities have no desire to obtain improvements. The contrary is the fact, real improvements are eagerly welcomed. The greater part of the work thus uselessly done is done through sheer ignorance. Few people outside those engaged in the everyday work of telegraphic maintenance know when improvements are needed, and the same holds good with telephony, lighting, and traction. Scores, nay, hundreds of patents are taken out which are utterly valueless, because the patentee is really about ten years behind actual workshop practice, and what he thinks is new is really old. It ill becomes us to complain, yet hardly a week passes but electrical inventors desire aid in exploiting their inventions, and, when examined, are found never to regularly read the technical papers, know absolutely nothing of similar work that has been described and discussed over and over again. They insist that their invention is worth millions—every electrical invention is, according to the views of inventors—and will revolutionise the affairs of the world. The results obtained in fairy tales are less marvellous than those to be obtained by the introduction of this invention, the only thing wanting is money to bring it before the purchasing world. To tell these inventors the truth, means to make oneself disagreeable. If you will advance a few hundreds, you can get the promise of as many thousands so soon as the invention succeeds. Perhaps, some papers, such as we have suggested, would do good. Telephony, for example, moves slowly. It is not perfect. What are its imperfections? It is easy to talk about successes, to congratulate the successful inventor, but to the would-be inventor a success means so much work done, and so much less room for his labours. Let us have a congress devoted to failures and to breakdowns. Let us have all the damaging facts brought out, and the more clearly they are brought out the better it will be for future progress. The pretending that any of these branches of industrial art is more perfect than it really is tends to damage and not to support. It may be asked why we do not make more capital out of failures if we think a knowledge of them so important. The answer is not far to seek. The province of every technical journal is to provide for those who examine its columns, and not to waste its powers upon those who, in their own estimation, know all and a good deal more than it can tell them, and therefore never venture to read, mark, or digest anything written therein. Further, it is a delicate matter to criticise failures, and what might be generalised in a congress paper would probably be individualised in a technical journal. The one would deal with a number of failures, the other would treat them as they arose from week to week. The latter would probably do more harm than good. One failure does not prove a case, but if a number of similar failures occur, it proves that something is wrong at that point in the system. Perhaps no remedy can be suggested, hence a clear direction in which inventive talent may work.

The exhibition authorities might influence some one in each prominent branch of electrical industry to attempt such a paper. In many directions we see accomplished that which the wise men in years gone by deemed to be impossible, and thus may be tempted to eradicate the term "can't" from the dictionary. State the end to be aimed at as clearly as possible, giving a clear idea of progress up to date, and further steps will soon be taken, with a less expenditure of time, energy, and money than which so many are seeking they know not what, only it is a something that must obtain them fame and wealth.

CORRESPONDENCE.

ELECTRIC TRAMWAY SYSTEMS.

To the Editor of The Electrical Engineer.

Sir,—Messrs. Waller and Manville appear to be under the impression that my system is merely an untried idea. This is quite an erroneous notion, as it was tried on a narrow gauge line soon after the completion of the patent with most satisfactory results, though there were one or two slight modifications which had to be introduced—and in what invention is there not that is tried for the first time? I found that a much better connection with the cable was obtained if a rubbing contact was employed, and so devised a collecting arm in which the collecting piece was a solid block of metal that could be easily renewed, and fitted with a guard preventing the cable accidentally riding off, yet allowing it to be readily removed when desired.

My experience of electric tramway work (and I fancy I have had quite as much experience as either Mr. Waller or Mr. Manville) has convinced me that *simplicity* is one of the chief things to be aimed at in an electric tramway system, and that a complicated or ramshackle contrivance proves in actual practice nothing but an endless source of annoyance. Messrs. Waller and Manville seem to have mistaken this simplicity in my system for imperfect development.

True, in my specification I have not shown any method of stretching the cable, and my subsequent experience has proved to me that this is unnecessary, and, in fact, a disadvantage, as it only complicates matters, especially at curves. Take the case of a tram line with 50 cars at work on it (a small number compared to that on some of our suburban lines), would it be practicable to stretch and insulate the huge conductor necessary to carry the large current by the method shown in the Waller-Manville system? It will be seen that in my system this is fully provided for by the "feed" conductor, so that the collecting cable need never exceed a certain size.

I presume Messrs. Waller and Manville intend their system for parallel working, for it is scarcely applicable to series, though from the size of the cable shown in their illustrations one would almost be led to suppose so. Is not this finding Saul among the prophets, or are we to take it that the series system has proved a failure?

Messrs. Waller and Manville say they can see no resemblance between the two systems. Perhaps this is not surprising, since there are none so blind as those who won't see. It would appear from Messrs. Waller and Manville's letter that previous to last week they had never seen either Mr. Volk's or my specifications. If this is the case it would perhaps be as well to inform them that there are more specifications of electric tramway systems in the Patent Office, notably those of Holroyd Smith, Trail, Wynne, and Lineff and Jones, a careful perusal of which might prevent their discovering any more "mares' nests."

In conclusion, I may add that I shall shortly be able to show Messrs. Waller and Manville a full gauge tramway on my system, which will, I think, convince them that it is a practical success, and that I am quite capable of working out my own inventions.—Yours, etc.,

F. C. Allsop.

165, Queen Victoria-street, E.C.,
May 26, 1890.

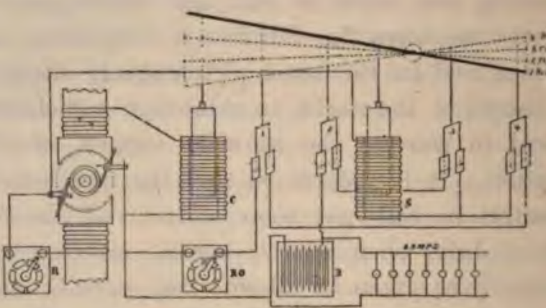
AUTOMATIC SWITCH FOR ACCUMULATORS.

BY CHARLES A. PFLUGER.

The switch represented in the accompanying cut was designed by the writer to facilitate the charging of storage batteries. If this operation can be rendered automatic it is manifest that the use of cells is made much more desirable and convenient. The automatic apparatus shown in the diagram is required to perform the following operations: First, if the dynamo is running at sufficient speed the accumulators are switched on; second, if the dynamo is running too slowly they are switched off; third, if the dynamo is running too fast the batteries must be switched off; and fourth, they are switched off when fully charged.

The switching apparatus, as shown in the cut, consists of two coils, C and S, with cores, a swinging arm or lever, with a counter weight, four pairs of mercury contacts, 1, 2, 3, and 4, and a suitable resistance, R O. The coil C is inserted in circuit with the field-magnets of the shunt-wound dynamo. It has from 100 to 200 ampere-turns in actual use. The iron core of this coil is attracted when the tension between the brushes of the dynamo reaches a certain point. The coil S is inserted in the positive conductor leading to the battery. It has only 10 ampere-turns, and the core hangs at a point which is one-quarter the distance of the first core from the balancing point of the lever.

The swinging arm may assume four different positions, as shown by the heavy line and dotted lines in the diagram. First, the arm is at rest when the dynamo stops, and consequently no current is flowing through the coil C. The mercury contacts 1 and 2 are interrupted, and the mercury contacts 3 and 4 are closed. The second position of the arm is that which it takes when the dynamo is starting, and is developing from 100 to 120 volts. The core in coil C is attracted, and mercury contact 1 is closed. Contact 2 is open, and contacts 3 and 4 are still closed. A limited quantity of the current passes through coil S, then through contact 4, contact 1, resistance R O, and thence to the dynamo.



The third position is that of charging. The dynamo is running at from 100 to 120 volts, current is passing through coil S, attracting its core, closing contact 2 and opening contact 4, and entering the battery. Contact 3 is still closed. The fourth position is that which the switch assumes when the dynamo is running at too high speed; contact 3 is opened, and the main current to the battery is broken. The swinging arm assumes its permanent position, which must be released when the dynamo again assumes its normal speed. If the battery has been fully charged, its E.M.F. is the same as that of the dynamo, and no current, therefore, is passing through coil S. The lever falls back into position 2 or 4, and is held by a mechanical device. The lever can be released at the switchboard if convenient. When lamps are used during charging hours, it will be necessary to employ resistance, which, of course, can be inserted automatically.

It is almost unnecessary at the present day to speak of the fact that a storage battery installation is a most desirable and convenient means of supplying electric currents. Take the case of a country mansion, which it is desirable to illuminate by electric light. It may be very inconvenient to install a steam plant, but by using a storage battery it may be possible to utilise other power to great advantage. Water power can frequently be economically employed, and a turbine wheel, developing from 1 h.p. to 3 h.p., would in many cases be sufficient. Windmills can also often be employed to great advantage, though, of course, this power is extremely irregular. The plan of lighting a country house, such as has been referred to, might be arranged as follows: Suppose 30 incandescent lamps are required. Not over half of this number would be required at any time, and these would not burn over five hours on an average each day. Current is furnished by a battery which will have about 80 per cent. efficiency under ordinary circumstances. About 45 ampere-hours will be taken out of the battery, each lamp using 6-10 of an ampere at 100 volts pressure. It will be necessary to use 5,600 watt-hours to charge the battery, and for this work about 7½ h.p. would be required. If the dynamo has an efficiency of 80 per cent., 9 4-10 horse-power hours are required. If wind power were employed, the battery should be at least four times as large, because there will be days when there will be no power available for charging the cells. In this case, however, 200 ampere-hour cells would be sufficient. With such a storage battery plant and an efficient dynamo the lighting of a small mansion could be effected with great success. It is manifest that the use of such switch as that described would be decidedly advantageous in such an installation.—*Western Electrician.*

INSTALLATIONS IN FRANCE AND ALGERIA.

The following list of towns in France and Algeria possessing installations of electric light is published in the *Bulletin Internationale de l'Electricité*, and has been brought as far as possible up to the present date. The first name given is that of the county.

Ain.—*Nantua* : Partial distribution of electricity (Guitton, engineer).—*Pont de Vaux* : Electric lighting of the town.

Allier.—*Montluçon* : "Société Anonyme d'Eclairage Electrique de Montluçon" (Mora, manager).

Ariège.—*Aix-les-Bains* : Municipal central station, 100 lamps, and private lighting, since October, 1888. Waterpower (M. Brillouin, engineer).

Basses-Alpes.—*Manosque* : Local Electric Light Company (40 h.p., 95 lamps, 16 c.p. for the streets, and 216 lamps 16 to 20 c.p. for private houses).

Ardèche.—*Bourg-Saint-Andéol* : Electric light company (Lauzan, director).

Ardennes.—*Rethel* : "Société Electrique Rethelaise" at Sault-le-Rethel (Gauson, manager).

Aveyron.—*Espalion* : Electric lighting of the town (Lamy et Cie.).

Marseille.—Station at the Rue de Pavilion (250 h.p.) of the "Compagnie du Gaz de Marseille." Station at the Rue Curiol No. 23 (200 h.p.) (M. Gillibert, director).

Charente.—*Angoulême* : Central station, 300 lamps, steam engines, since January, 1888 (M. Brillouin, engineer); made over to the gas company in February, 1890. Installation of 1,000 lamps now being erected (Brillouin).

Charente-Inférieure.—*Marennes* : Electric light station (Guitton, engineer).

Cher.—*Vierzon-Ville* : Electric light station (Guitton, engineer).

Côte-d'Or.—*Dijon* : Electric light station (De Brancion, engineer).

Creuse.—*Bourganeuf* : Electric lighting, station at Nisme (Marcel Deprez, engineer).

Dordogne.—*Périgueux* : Electric station (Guitton, engineer. *Montpont* : Electric lighting (Guitton, engineer).

Drôme.—*Dieulefit* and *Valréas* : Supplied by the central station at *Bécone* (Lombard-Gérin, manager).

Finistère.—*Châteaulin* : Electric light station (Lamy et Cie.).

Gard.—*Lassalles* : Municipal electric lighting. *Valleranges* : Public lighting of the town (Lamy et Cie.).

Gironde.—*Bordeaux* : Partial electric lighting station, 24, Rue Saint-Colombe (Société Edison).

Haute-Garonne.—*Toulouse* : "Société Toulousaine d'Electricité," 10, Quai Saint-Pierre.

Indre-et-Loire.—*Tours* : Electric light station (Compagnie Internationale d'Eclairage Electrique).

Isère.—*Grenoble* : Electric lighting of the town, 900 lamps. *Rives* : Electric light works.

Jura.—*Nantua* : Electric light station.

Loire-et-Cher.—*Saint-Aignan* : Central electric lighting station.

Loire.—*Saint-Etienne* : Central electric supply (200 h.p.) (Société Edison).

Lozère.—*Mende* : Central electric light station (Lamy et Cie.).

Manche.—*Saint-Hilaire-du-Harcouet* : Water power electric station (Lamy et Cie.).

Meuse.—*Verdun* : Central station since 1888 (Couten et Duhamel).

Meurthe-et-Moselle.—*Nancy* : "Compagnie Nancéenne d'Eclairage Electrique."

Marne.—*Reims* : Electric light works.

Morbihan.—*Hennebont* : Electric lighting of the town (Bonfante, manager).

Nord.—*Cambrai* : Central electric light works.

Oise.—*Compiègne* : Electric light station, Rue Pierre-Sauvage.

Orne.—*Domfront* : Electric lighting of the town.

Basses-Pyrénées.—*Pau* : Central electric light station, town and private lighting, since January, 1888 (Brillouin). Steam power, 1,500 lamps, made over to Société Electrique des Pyrenées in May, 1889. Extension by waterpower now being erected.—*Nay* : Central station, 1,500 lamps being erected, waterpower (Brillouin).—*Oloron* : Electric lighting of the town d'Eaux Bonnes, 32, Rue Chanzy.

Hautes-Pyrénées.—*Argelès* : Central station, municipal and private lighting, steam, erected in July, 1887 (A. Brillouin). Waterpower installation now being erected.

Pyrénées-Orientales.—*Perpignan* : Electric light works, Rue des Abreuvoirs (Lamy et Cie.).

Rhône.—*Lyon* : Central station, 7, Rue de Savoie (the Gas Company), "Compagnie Lyonnaise d'Eclairage Electrique" (600 h.p.).

Sarthe.—*Le Mans* : Electric light works (the Gas Company, Seguin). — Central station, Société Générale d'Electricité du Mans, May, 1887; taken over again by M. Brillouin, June, 1889, 500 lamps.

Savoie.—*Modane* : Electric light works (Fardel, manager).

Haute-Savoie.—*La Rôche-sur-Foron* : Electric light works (Garnot).

Seine.—*Paris* : Municipal lighting; Cie. Continentale Edison; Cie. Victor Popp; Société de la Transmission de la Force par l'Electricité; private companies lighting the islands on the Seine.

Seine-Inférieure.—*Rouen* : Electric light works (100 h.p.), 87, Rue Lafayette; Société Normande d'Electricité, 14, Rue du Petit-Salut, October, 1888 (MM. Lelordier et A. Brillouin); steam power, 300 h.p., 2,400 lamps.—*Le Havre* : Electric light works (Mildé et Cie.).

Vaucluse.—*Pertuis* : Electric lighting of the town.

Vendée.—*La Roche-sur-Yon* : Electric light works (50 h.p.).

Haute-Vienne.—*Limoges* : Electric light works, Carrefour Tourny (Lamy et Cie.).

Yonne.—*Saint-Fargeau* : Electric lighting of the town (Luneau et Plagneux).

ALGERIA.—*Milianah* : Electric lighting of the town (Galli et Dalloz).—*Orléansville* : Electric lighting of the town (Galli et Dalloz).

As will be seen, several gas companies supply electric light at the same time as gas.

PROF. ELIHU THOMSON'S ELECTROMAGNETIC INDUCTION EXPERIMENTS.*

BY J. A. FLEMING, M.A., D.SC., M.I.E.E.

(Continued from page 414).

So strong is this repulsion, with proper appliances, that light copper rings tethered by strings may be held suspended in the air against the force of gravity, the upward electromagnetic repulsion overcoming their weight, and holding them, like Mahomet's fabled coffin, floating in the air (Fig. 11). In cases where we are dealing only with impulsive effects, aluminium rings or discs give most marked results, because aluminium has the highest conductivity per unit of mass; but in the cases like those just considered, where what is required is the greatest force effect, copper or silver gives a better result than aluminium, because they have the highest conductivity per unit of volume. In Mr. Boys's experiments, if I remember rightly, he found aluminium the best to employ. In these cases of electro-dynamic repulsion the force effect depends essentially upon the lag of the induced current, or its retardation in phase behind that of the inducing field, and, other things being equal, this is proportional to the conductivity of the circuit. I will pass before your view a series of diagrams intended to represent various cases and modes of production of these repulsive effects, giving you descriptions of them in Prof. Elihu Thomson's own words. He says:

"This preponderating repulsive effect may be utilised, or may show its presence by producing movement or pressure in a given direction by producing angular deflection as of a pivoted body, or by producing continuous rotation in a properly-organised structure.

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* Paper read before the Society of Arts, May 14, 1890.

"In Fig. 12 C is a coil traversed by alternating currents, B is a copper case or tube surrounding it, but not exactly over its centre. The copper tube, B, is fairly massive, and is the seat of heavy induced currents. There is a preponderance of repulsive action tending to force the two conductors apart in an axial line. The part B may be replaced by concentric tubes slid one in the other, or by a pile of flat rings, or by a closed coil of coarse or fine wire, insulated or not. If the coil C, or primary coil, is provided with an iron core, such as a bundle of fine iron wires, the effects are greatly increased in intensity, and the repulsion with a strong primary current may become quite vigorous, many pounds of thrust being producible by apparatus of quite moderate size.

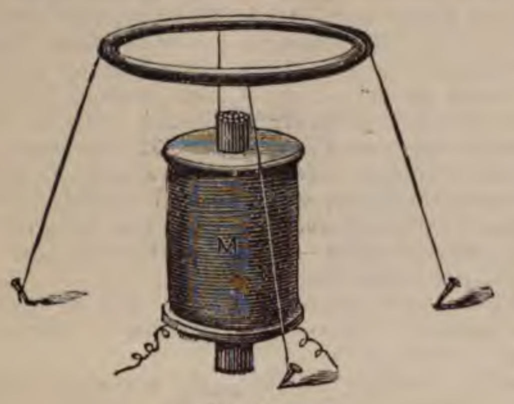

FIG. 11.

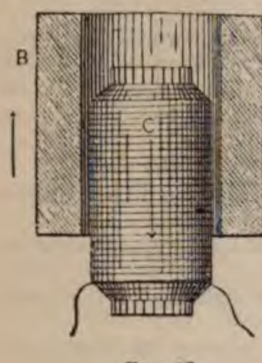

FIG. 12.

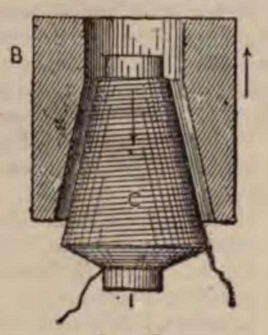

FIG. 13.

"The forms and relations between the two parts, C and B, may be greatly modified, with the general result of a preponderance of repulsive action when the alternating currents circulate.

"Fig. 13 shows the part B of an internally tapered or coned form, and C of an externally coned form, wound on an iron wire bundle, I. The action in Fig. 12 may be said to be analogous to that of a plain solenoid with its core, except that repulsion, and not attraction, is produced; while that of Fig. 13 is more like the action of tapered or conically-wound solenoids and taper cores. Of course, it is unnecessary that both be tapered. The effect of such shaping is simply to modify the range of action and the amount of repulsive effort existing at different parts of the range.

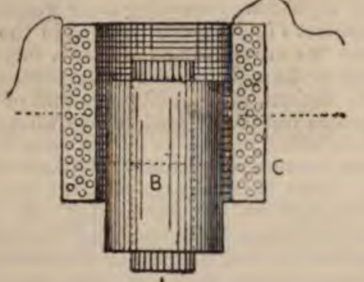

FIG. 14.

"In Fig. 14 the arrangement is modified so that the coil, C, is outside, and the closed band or circuit, B, inside and around the core, I. Electro-inductive repulsion is produced as before.

"It will be evident that the repulsive actions will not be mechanically manifested by axial movement or effort, when the electrical middles of the coils or circuits are coincident. In *cylindrical coils,* in which the current is uniformly distributed through all the parts of the conductor section, what I here term the electrical middle, or the centre of gravity of the ampere-turns of the coils, will be the plane at right angles to its axis at its middle, that of B and C in Fig. 14 being indicated by a dotted line. To repeat, then, when the centres or centre planes of the conductors, Fig. 14, coincide, no indication of electro-inductive repulsion is given, because it is mutually balanced in all directions; but when the coils are displaced a repulsion is manifested, which reaches a maximum at a position depending on the peculiarities of proportion and distribution of current at any time in the two circuits or conductors.

"In Fig. 15 B represents a copper ring, and C an annular coil placed parallel thereto; and an iron core or wire bundle placed in the common axis of the two coils, shows the repulsive action when an alternating current is passed through C. B may be simply a disc or plate of any form, without greatly affecting the nature of the action produced. It may also be composed of a pile of copper washers or a coil of wire, as before indicated.

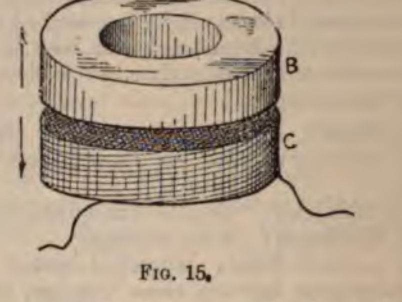

FIG. 15.

"An arrangement of parts somewhat analogous to that of a horseshoe electromagnet and armature is shown in Fig. 16. The alternating-current coils, C C′, are wound upon an iron wire bent into U-form, and opposite its poles is placed a pair of thick copper discs, B B′, which are attracted and repelled, but with an excess of repulsion depending on their form, thickness, etc.

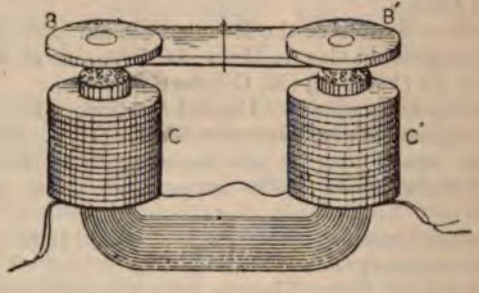

FIG. 16.

"If the iron core takes the form of that shown by I I, Fig. 17, such as a cut ring with the coil, C, wound thereon, the insertion of a heavy copper plate, B, into the slot or divided portion of the ring will be opposed by a repulsive effort when alternating currents pass into C. This was the first form of device in which I noticed the phenomenon of repulsive preponderance in question. The tendency is to thrust the plate, B, out of the slot in the ring, excepting only when its centre is coincident with the magnetic axis joining the poles of the ring between which B is placed.

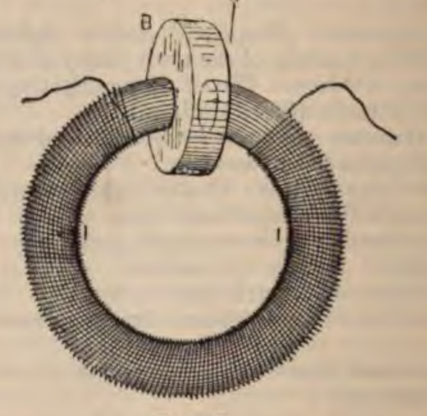

FIG. 17.

"If the axes of the conductors (Fig. 15) are not coincident, but displaced, as in Fig. 18, then, besides a simple repulsion apart, there is a lateral component or tendency, as indicated by the arrows. Akin to this is the experiment illustrated in Fig. 19. Here the closed conductor, B, is placed with its plane at right angles to that of C, wound on a wire bundle. The part B tends to move toward the centre of the coil C, so that its axis will be in the middle plane of C, transverse to the core, as indicated by the dotted line. This leads us at once to another class of actions—*i.e.*, deflective actions.

"When one of the conductors, as B (Fig. 20), is composed of a disc, or, better, of a pile of thin copper discs, or of a closed coil of wire, is mounted on an axis, X, transverse to the axis of coil C, through which coil the alternating current passes, a deflection of B to the position indicated by dotted lines will take place, unless the plane of B is at the start exactly coincident with that of C. If slightly inclined at the start deflection will be caused as stated. It matters not whether the coil C encloses the part B, or be enclosed by it, or whether the coil C be pivoted, and B fixed, or both be pivoted. In Fig. 21 the coil C surrounds an iron-wire core, and B is pivoted above it, as shown. It is deflected, as before, to the position indicated in dotted lines.*

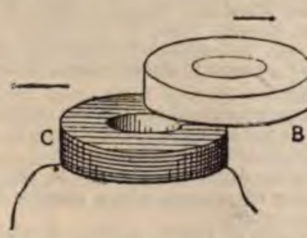

Fig. 18.

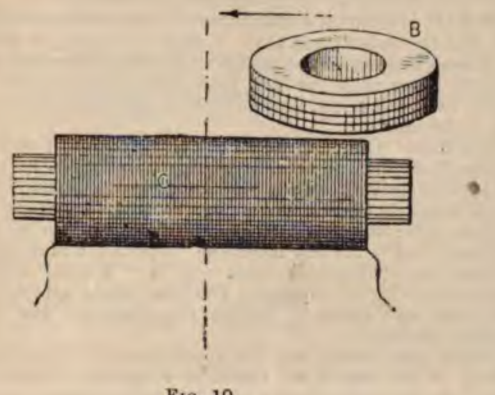

Fig. 19.

"It is important to remark here that in cases where deflection are to be obtained, as in Figs. 20 and 21, B had best be made of a pile of thin washers or a closed coil of insulated wire, instead of a solid ring. This avoids the lessening of effect which would come from the induction of currents in the ring, B, in other directions than parallel to its circumference."

Returning for a moment to the theory of these repulsive and deflective actions, it will repay us to consider it in the form placed before us by Prof. Thomson, in his first paper on the subject, read before the American Institute of Electrical Engineers, May 18, 1887. He says: "It may be stated as certainly true that, were the induced currents in the closed conductor unaffected by any self-induction, the only phenomena exhibited would be alternate equal attractions and repulsions, because currents would be induced in opposite directions to that of the primary current when the latter current was changing from zero to maximum positive or negative current, so producing repulsion; and would be induced in the same direction when changing from maximum positive or negative value to zero, so producing attraction.

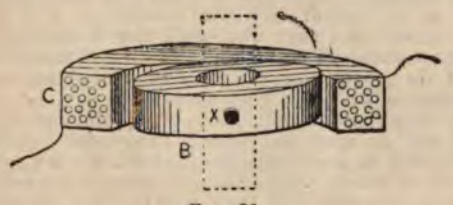

Fig. 20.

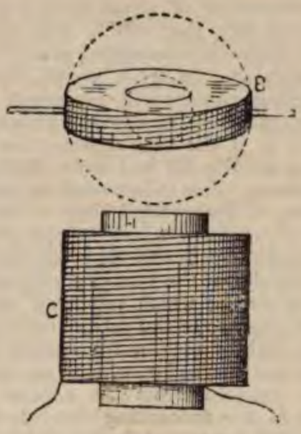

Fig. 21.

"This condition can be illustrated by a diagram, Fig. 22. Here the lines of zero current are the horizontal straight lines. The wavy lines represent the variations of current strength in each conductor, the current in one direction being indicated by that portion of the curve above the zero line, and in the other direction by that portion below it. The vertical dotted lines simply mark off corresponding portions of phase or succession of times.

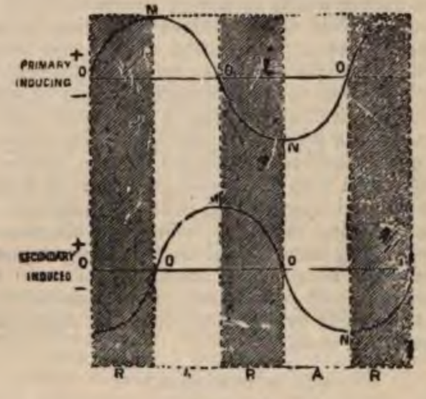

Fig. 22.

"Here it will be seen that in the positive primary current descending from m, its maximum, to the zero line, the secondary current has risen from its zero to m^1, its maximnm. Attraction will therefore ensue, for the currents are in the same direction in the two conductors. When the primary current increases from zero to its negative maximum, n, the positive current in the secondary closed circuit will be decreasing from m^1, its positive maximum, to zero; but as the currents are in opposite directions, repulsion will occur. These actions of attraction and repulsion will be reproduced continually, there being a repulsion, then an attraction, then a repulsion, and again an attraction, during one complete wave of the primary current. The letters r, a, at the foot of the diagram, Fig. 22, indicate this

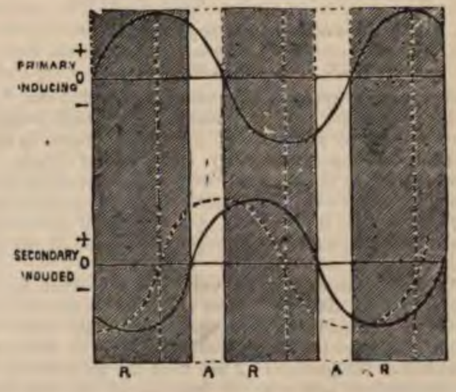

Fig. 23.

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* This deflection by an alternating current of a copper disc suspended within a coil with its plane inclined to the plane of the coils, I myself noticed independently in March, 1887, and subsequently described a copper-disc galvanoscope for alternating currents, based on this fact (see *The Electrician*, May 6, 1887). I did not at the time know how thoroughly Prof. Thomson had explored the phenomena, but the substantial explanation of it had already occurred to me.

succession. (The shaded portions in the diagrams represent the time during which the force between the primary and secondary circuits is a repulsive force.)

"In reality, however, the effects of self-induction in causing a lag, shift, or retardation of phase in the secondary current will considerably modify the results, and especially so when the secondary conductor is constructed so as to give such self-induction a larger value. In other words, the maxima of the primary or inducing current will no longer be found coincident with the zero points of the secondary currents. The effect will be the same as if the line representing the wave of the secondary current in Fig. 22 had been shifted forward to a greater or less extent. This is indicated in diagram, Fig. 23. It gives, doubtless, an exaggerated view of the action, though from the effects of repulsion which I have produced I should say it is by no means an unrealisable condition.

"It will be noticed that the period during which the currents are opposite, and during which repulsion can take place, is lengthened at the expense of the period during which the currents are in the right direction for attractive action. These differing periods are marked *r*, *a*, etc., or the period during which repulsion exists is from the zero of the primary or inducing current to the succeeding zero of the secondary or induced current, and the period during which attraction exists is from the zero of the induced current to the zero of inducing current. (It will be seen that the shaded portions in Diagram 23 have been widened out at the expense of the unshaded parts.)

"But far more important, still, in giving prominence to the repulsive effect than this difference of effective period is the fact that during the period of repulsion both the inducing and induced currents have their greatest values, while during the period of attraction the currents are of small amounts comparatively. This condition may be otherwise expressed by saying that the period during which repulsion occurs includes all the maxima of current, while the period of attraction includes no maxima. There is, then, a repulsion due to the summative effects of strong opposite currents for a lengthened period against an attraction due to the summative effects of weak currents of the same direction during a shortened period, the resultant effect being a greatly preponderating repulsion.

"It is now not difficult to understand all the actions before described, as obtained with the varied relations of coils, magnetic fields, and closed circuits. It will be easily understood, also, that an alternating magnetic field is in all respects the same as an alternating-current coil in producing repulsion on the closed conductor, because the repulsions between the two conductors are the result of magnetic repulsions arising from opposing fields produced by the coils when the currents are of opposite directions in them."

(*To be continued.*)

THE TREATMENT, REGULATION, AND CONTROL OF ELECTRIC SUPPLY BY THE LEGISLATURE AND THE BOARD OF TRADE.*

BY MAJOR P. CARDEW, R.E., MEMBER.

(*Continued from page 415.*)

NATURE AND MODE OF SUPPLY.

In the old orders two systems were mentioned—viz., the "parallel system" and the "series system," meaning constant-pressure and constant-current systems respectively. Now no system is specified, except that it must be one approved by the Board of Trade. A new sub-section was added to this last year at the instance of the telephone companies, by agreement with the promoters, for the protection of the telephone circuits against interference by induction or otherwise, they being naturally rather alarmed at the proposed general use of alternating currents.

In the "Works" clauses, I need only mention that in the new model it is proposed to give powers for the construction of "street" boxes in place of "distributing" boxes. The special power taken is necessary, I believe, because these boxes come up to, and may come above, the surface of the ground. Also, that the prohibition of overhead wires, introduced last year, is inserted in the new model for companies, with the alteration that the time allowed for removal of existing overhead wires is reduced to one year. But they may be erected or continued in use with the consent of the local authority. This prohibitory section is based upon, and really does not go beyond, section 14 of the Act of 1882.

The "Compulsory Works" clauses provide generally that the undertakers shall do something substantial towards carrying out their undertaking within a specified time, under penalties of fine or revocation of the orders. The Board of Trade, however, must, in the the case of a company, be moved to exercise its power of revocation by the local authority, except in the last model, where this has been altered; while in the case of a local authority being the undertakers, the Board of Trade has not hitherto, so far as I am aware, thought fit to exercise its power of revocation for non-performance of works within the required time, probably considering the plea that the practical knowledge and experience of electrical distribution was not sufficient to justify any expenditure of public funds, a valid one. This plea, however, is obviously daily diminishing in force. In nearly all orders the specified time within which mains have to be laid in certain streets is two years. It is three years in the Birmingham Order of last year, but all streets within the area are included. The Liverpool Order is also an exception.

In the old orders two years was also the period that had to elapse before any supply could be requisitioned in other streets, and six months more is allowed to comply with the requisition. In last year's London orders and the new forms, however, supply can be requisitioned after 18 months, with six months for compliance; so that persons in streets not scheduled can get a supply at the same time as those in scheduled streets. Also, in the recent orders, as already mentioned, supply can be requisitioned for any part of the area included in the order; whereas in the old orders it could only be requisitioned for the A district.

There is a slight variation, too, in wording, which may be important, viz., whereas in the old orders mains were to be laid *in* every street, now it is *throughout* every street.

The requisition to lay distributing mains in any street has to be signed by a number of persons, which number is a very variable quantity in different orders.

Thus in the old orders of 1883 it was two or more owners or occupiers in the case of an order given to a company or person, and the owners or occupiers of not less than one-fourth of the premises in the street in the case of a local authority. In the Chelsea Order of 1886 it was six or more owners or occupiers.

Last year the Board of Trade reverted to the former practice both in the case of companies and local authorities, except in the Birmingham and Liverpool Orders, where no power of requisitioning is given to owners. These two orders are very exceptional in respect of these clauses.

This year, in the model forms, which are not intended to apply to London, it is proposed to follow the precedent of the Chelsea Order, and to require six signatures to a requisition, the number being the same both for local authority and company orders.

After the requisition clause follows a long clause intended to provide that the undertakers shall, if they so require, be guaranteed by the persons making the requisition a return for their outlay in laying the requisite mains of 20 per cent. per annum for three years in the old orders, two years in the London Orders, and again three years in the new model orders.

After these "Compulsory Works" clauses come a few clauses headed "Maps," and then, in the old orders, "Regulations as to supply on the parallel system." These regulations are not inserted in any of the recent orders, but are issued separately with the safety regulations. Then we come to some clauses headed "Testing" in all orders up to this year; but in the new models an improved arrangement has been followed, and "Supply" comes next to "Works," which certainly seems a more logical sequence; also, the clauses applying to the appointment and duties of electric inspectors are now put under a separate heading.

Taking these clauses first, the appointment of electric inspectors is vested, in the case of all orders to companies, except the London Orders, in the local authority; in the London Orders it is vested in the County Council; and in all existing local authority orders in a court of summary jurisdiction, moved either by a consumer or by the undertakers themselves. In the new model this appointment is vested in the Board of Trade. In case of the local authority not appointing an inspector, or imperfectly attending to inspectional duties, there is a provision in all company orders for appointment, in some cases by a magistrate, in others by the Board of Trade.

In the new model orders a clause has been added specially stating that the Board of Trade may appoint an inspector for the purposes of any enquiry on an accident or as to safety. I think it is obvious that the Board of Trade has in any case, whether expressed in the order or not, the right to make enquiry as regards safety.

All local inspectors are to be paid by the local authority, or County Council for London; but fees may be charged by means of which part, at any rate, of the cost of inspection will be recouped.

Inspectors may be appointed from time to time for particular services, or the appointment may be continuous. It is rather difficult to see how this matter will work in small towns where there may be no resident electrician unconnected with the undertakers, or, at any rate, none who would care to undertake the job for such remuneration as could be offered without unduly increasing the cost of the supply, since the expenses of inspection must in one way or another be borne by the consumers.

Probably one electrician will secure the appointment for several towns not very far apart, and reside in a convenient locality for his district. It will be something like the birth of a new species; and some follower of Darwin will in the next century write an exhaustive monograph on the genesis of the electric inspector, showing how he came to differentiate from ordinary mortals, how he gradually acquired an extra sense warning him against high pressure, etc.

The duties of electric inspectors are clearly defined in the new model orders, as follows:

> The duties of an electric inspector under this order shall be as follows:
>
> (*a*) The inspection and testing, periodically and in special cases, of the undertakers' electric lines and works, and the supply of energy given by them.
>
> (*b*) The certifying and examination of meters; and
>
> (*c*) Such other duties in relation to the undertaking as may be required of him under the provisions of this order, or of any regulations under this order,

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* Paper read before the Institution of Electrical Engineers.

The next clauses in the new models are headed "Testing and inspection;" and this is an improvement on the old heading of "Testing" alone, since it is obvious that in the case of a network of mains a good deal may be found out by inspection that could hardly be arrived at by testing. These clauses have been greatly altered, and I would especially draw attention to a new clause—

> 40. An electric inspector, if and when required to do so by any consumer, shall from time to time, on payment by the consumer of the prescribed fee, test the variation of electric pressure at the consumer's terminals, or make such other inspection and testing of the service lines, apparatus, and works of the undertakers upon the consumer's premises as may be necessary for the purpose of determining whether the undertakers have complied with the provisions of this order, and the regulations and conditions subject to which they are for the time being authorised to supply energy;

which is, I think, very practical, and may have important results. This clause takes the place of the following in the existing orders:

> 35. Every electric inspector, if and when required to do so by any person supplied with energy by the undertakers, shall from time to time test for insulation and conductivity any service lines by which such energy is supplied and the efficiency of any joints in such service lines, and make such other tests in relation to such service lines as may from time to time be approved of by the Board of Trade.

In all orders there is a clause providing for the establishment of testing stations at various points in the area, either by the undertakers or by the local authority. I am not aware that any such testing stations have yet been established; but I believe that in several districts in London they are to be established for one position, at any rate—at the office of the local authority. The practical use of these stations is obviously to obtain a record of the variations of pressure at different points in the system, and of the duration of any abnormal pressure or stoppage of supply. The best solution appears to be to have a recording voltmeter at each station, which might be made in the shape of a pillar box; and possibly an indicating voltmeter exhibiting the pressure at any time would be a welcome addition. I consider that the production of a thoroughly trustworthy recording voltmeter is distinctly a desideratum for the improvement of electric supply. There appear to be very few such instruments in use at the present time.

In all orders I think there is reserved an appeal to the Board of Trade against any report of any electric inspector. It is to be hoped that this power will be used with discretion, as the electrical staff of the Board of Trade is strictly limited at present.

Now, taking the "Supply" clauses, we have, first, that any owner or occupier of premises situated within a certain distance of any district main can demand a supply. This distance is in the 1883 orders 25 yards; in the London Orders and the new forms 50 yards. He may be required, however, to pay the cost of service lines beyond a distance of 30ft. in the old, 60ft. in the London and new model orders. He must name a maximum current in the old orders, or a maximum power in the new, so that the proper size of service lines may be laid, and this maximum must not be larger than what may reasonably be expected to be the consumption on the premises; and if afterwards he wishes to go beyond the declared maximum, he must be prepared to pay for any alteration of service lines or apparatus thereby rendered necessary.

The person requiring a supply must also be prepared to make a contract to take and pay for a supply for at least two years of sufficient amount to pay 20 per cent. on the outlay incurred by the undertakers.

Then follow provisos as regards security for payment, prohibition of improper use of the supply, and a very important one added last year, which I will read.

The "Price" clauses have been considerably affected by the supply being now considered a supply of energy, and not, as formerly, of electricity. I will read the first clause as it stood in the old orders and in the London Orders:

> 31. The undertakers may charge for electricity supplied by them to any consumer (otherwise than by agreement)—
>
> (1.) By the quantity of energy contained in such supply; or
>
> (2.) By the actual quantity of electricity so supplied; or, unless the Board of Trade from time to time otherwise direct,
>
> (3.) By the number of hours during which the supply of electricity is actually used by such consumer, and the maximum current with which he is for the time being entitled to be supplied.

> 50. The undertakers may charge for energy supplied by them to any ordinary consumer (otherwise than by agreement)—
>
> (1.) By the actual quantity of energy so supplied; or
>
> (2.) By the electrical quantity contained in such supply; or, unless the Board of Trade from time to time otherwise direct,
>
> (3.) By the number of hours during which the supply of energy is actually used by such consumer, and the maximum power with which he is for the time being entitled to be supplied.

In the new models method (3) has been altered as follows:

> 32. The undertakers may charge for energy supplied by them to any ordinary consumer (otherwise than by agreement)—
>
> (1.) By the actual amount of energy so supplied; or
>
> (2.) By the electrical quantity contained in such supply; or
>
> (3.) By such other method as may for the time being be approved by the Board of Trade.

The reason for this is that the old method (3) is decidedly wasteful, and, if generally adopted, would lead to far more energy than was necessary being supplied from central stations. Except in special cases, such as lighting of shops and business premises, it should be noted that the consumers are free to make any agreement they prefer as to the price to be charged and the method, but they have a right to be charged in accordance with methods (1) or (2), and the undertakers are always bound by the undue preference clause.

The meter clauses have hardly been altered at all, and it is, in my opinion, proof of the very great care and acumen with which these clauses were originally drawn, so far back as the year 1883, that no really satisfactory improvement has yet been proposed. These clauses will repay very attentive study. They are sometimes looked upon as stumbling blocks, and it is said that they are unintelligible, and that they won't work; but I am afraid that these difficulties are rather due to want of study and defects of meters than to the clauses themselves. They are too long to take in detail, but, roughly, the gist is as follows:

Any number and description of meters may be used both by consumer and undertakers, but only one meter is to be used for ascertaining the value of the supply. This is to be a meter certified by an electric inspector appointed under the order. Note that it cannot be certified by anyone else. The inspector must certify three things: (1st) That the meter is of some construction and pattern approved by the Board of Trade; (2nd) that it has been fixed and connected to the service lines in some manner approved by the Board of Trade, which must, therefore, in approving any pattern of meter, prescribe in what way it is to be fixed and connected to the service lines; (3rd) that it is a correct meter; and in making this last declaration the inspector, in my opinion, may reasonably take account of and be guided by any mark or certificate attached to the meter showing that it has been thoroughly tested and found sufficiently accurate to be pronounced a correct meter in some standardising laboratory, or he may himself carry out the necessary tests in a laboratory. It is obvious that he cannot thoroughly test it in the consumer's cellar, and also that the words "a correct meter" cannot be held to be only applicable to a meter that was absolutely perfect throughout its range.

The undertakers are to supply the consumer, either by purchase or hire, with a meter on demand, and procure its certification. No consumer is allowed to connect or disconnect the meter used for ascertaining the value of the supply without giving 48 hours' notice to the undertakers, under penalty.

If this meter belongs to the consumer he is to keep it in proper order, but if it is hired from the undertakers they must maintain it, and in either case they may remove it for testing, all expenses connected with the removal being paid by the consumer if the meter turns out to be faulty, and by the undertakers if it is in proper order; and any other meter or apparatus placed by the undertakers upon the consumer's premises for the purpose of ascertaining or regulating the supply of energy must be of some construction and pattern and connected in a manner approved by the Board of Trade.

The only other point in the orders of much electrical interest is the price schedule. In this the definition of the Board of Trade unit has remained unaltered, except the simplification of the wording. Last year there was, as you may remember, some agitation to have the amount of the unit increased tenfold. The point was referred to your council, who did not recommend the alteration, and the Board of Trade very willingly left it as it was. Of course undertakers are at liberty to make agreements for a price per 10 units, provided that the charges do not exceed the rates laid down in this schedule.

In the London Orders of last year there was added to the second section a proviso to enable the standard pressure on the mains to be taken into account in assessing the value of the supply where this pressure is a high pressure, and the energy is transformed; but in the new model this section has been much simplified by the introduction of a new term—viz., the declared pressure at the consumer's terminals, which it is proposed to deal with in the new regulations.

SAFETY REGULATIONS.

These were embodied in the old orders, and were in great detail, such points as the distance apart of terminals, and the maximum current to be taken from any pair of terminals, being specified. The pressure on distributing mains and service lines was not to exceed 200 volts continuous or 100 alternating; and no portion of any electric line placed above ground, and not enclosed, was to be at a pressure from earth exceeding 200 volts.

The St. Austell License of 1885 is, I think, the first license or order in which separate regulations have been issued; and the same form has been used in the Kensington and Knightsbridge Order of 1889 and the St. James's License of 1888, and nearly the same form in the Chelsea Order of 1886. These are more general in character. The limit of low pressure has been raised to 300 volts continuous, while alternating currents are not to be used except with the approval of the Board of Trade, and under such further regulations as may be considered necessary.

A very important innovation has also been introduced in these regulations, providing that the undertakers shall cut off any consumer upon whose premises they find that a leakage exists having a resistance to earth of less than 5,000 ohms. This is to some extent a departure from the policy of the Board of Trade to leave the regulation of the circuits on private premises to the insurance companies; but unfortunately electricity does not conform to these arbitrary distinctions, and a bad leak on a consumer's premises is just as much a source of danger and difficulty as one on the main outside—in the case of direct supply systems at any rate.

The general regulations for overhead wires, made under section 4 of the Act of 1888, are pretty generally known at the present time, and I need not dwell upon them. As you are aware, they were thoroughly revised by your council, who have also given their powerful assistance to the Board of Trade in the matter of some new proposed general regulations for undertakers of electrical supply, which, however, are still under discussion. The principal features of the new draft regulations are: (1) The division of the various systems of supply into three classes, viz., low pressure, high pressure, and extra high pressure; low pressure to extend to 300 volts continuous or 150 alternating; high pressure from above this to 3,000 volts, either continuous or alternating—that is, to as high a pressure as we have had practical experience of in distribution systems; extra high pressure, above 3,000 volts. (2) A general provision that where high-pressure conductors or apparatus are exposed in such positions as to be possibly touched by persons, or brought into contact with low-pressure conductors, they shall be entirely enclosed in strong metal casing efficiently connected to earth.

Supply Regulations.

These have been subjected to less alteration than the safety regulations. The variation of standard pressure permitted has been reduced, and in the new draft it is proposed, as already stated, to introduce the idea of a pressure to be declared at the consumer's terminals, which is not to vary more than 4 per cent., and the variation of which may be tested for the consumer on his application by the electric inspector.

It is also proposed to take advantage of the powers of the transformer system, and provide that the consumer supplied from a transformer on his premises shall have the choice of two pressures given him, one about half the other.

No doubt many of the regulations that have been made are open to criticism; but I would point out that they are in every case the result of very careful consideration, and that observations on them from many different points of view have been submitted, and given, as far as possible, their due weight. It is not unlikely, therefore, that a criticism, even from a high electrical authority, may be unjust and erroneous, from the critic not being acquainted with all the circumstances and conditions which have guided the Board of Trade; and it should also be borne in mind that the Board are empowered to alter any regulations issued by them, or to repeal them and issue fresh ones, should the progress of electrical discovery and further experience make such a course desirable.

And whatever imperfection may become apparent in these regulations, I can confidently affirm—and I feel sure that this proposition will receive the support of those among you who have experience of its methods of procedure—that the Board of Trade has been guided solely by the desire to do the duty imposed upon it by Parliament, and to serve the best interests of producers and consumers alike.

And now I should like to say a few words about the standardising laboratory. You are probably aware that the Board of Trade have, in deference to the wishes of the large body now interested in practical applications of electricity, as expressed by a powerful deputation to the President last year, undertaken to provide something in the nature of a testing establishment for instruments intended for the measurement of electrical quantities, analogous to the Standards Department of the Board of Trade for weights and measures of the more gross and material quantities. They have also taken powers under the Weights and Measures Act of last session to undertake such testing and verification, and to charge fees for it; so that these verifications, whatever their scientific value, will possess a legal value.

A general scheme for the scope and working of this laboratory was drawn up very carefully last year by a committee of your Institution, in connection with which I should like to mention especially the hard work done by Dr. Fleming in a cause which he has given abundant proof that he has at heart. The general idea embodied in this, in which I personally entirely concurred, is that the thing should grow from small beginnings. This, I think, is the English way, and I need only point to the present position of our own Institution as an example of its success. Our more impressionable neighbours on the other side of the Channel like to start these things in a different way. They must have something grand and striking, and of course there is much to be said for this view, if you have the means to carry it out; but it sometimes leads to, as it were, setting up a steam-hammer to crack nuts. No doubt the steam-hammer can do it very well, but a pair of nut-crackers is cheaper. Now I can promise that there will be nothing grandiose about our laboratory—we are starting with a very ordinary pair of nut-crackers.

It is hardly necessary to observe that the small beginnings idea was the part of the scheme most to the taste of the Treasury; in fact, to use an electrical metaphor, my Lords would have liked our electric particle to have acquired its potential of doing work by starting in the legitimate way at an infinite distance from the charged body (the national purse), and to have been a long time on the road too. However, let us not forget that if we are electricians we are also taxpayers!

Now what we hope to do in this laboratory is, first of all, to get the true values of the electrical units, within a very small possible percentage of error. We are not tied to the so-called legal units, which I may remark have no legal value in England; but with the assistance of Lord Rayleigh and the Standardising Committee of the British Association we hope to get even nearer the truth than was arrived at with this set of units. Secondly, having got there, we hope to keep there by well-devised checks and frequent reference to the fundamental measurement. This, as we are at present advised, will be the measurement of current by the quantity of silver deposited from solution in a determined time. Thirdly, as soon as we are satisfied that sufficient accuracy and permanence has been arrived at with our instruments and methods, we shall be ready to receive instruments, either for simple verification in the case of ordinary commercial instruments, at a small charge for each reading, or for thorough testing and certification in the case of instruments submitted as sub-standards.

(To be concluded.)

Leeds.—The International Exhibition at Leeds was opened on May 21. The buildings consist of five courts, with dining-rooms, kitchens, etc., covering an area of over 4,000 yards. The exhibits comprise an interesting collection of works of art and manufactures, and includes a variety of building appliances. The buildings and grounds are lighted by arc lights; the dynamos are driven by the "Griffin" gas-engine, supplied by Mr. Edwin Oldroyd, engineer, of Leeds.

PROVISIONAL ORDER.

FORM II.—UNDERTAKERS BEING A COMPANY OR PERSON.

(Concluded from page 417.)

Notices, &c.

64. Notices, orders, and other documents under this order may be in writing or in print, or partly in writing and partly in print, and where any notice, order, or document requires authentication by the local authority, the signature thereof by the clerk or surveyor to the local authority shall be sufficient authentication.

65. Any notice, order, or document required or authorised to be served upon any body or person under this order or the principal Act may be served by the same being addressed to such body or person, and being left at or transmitted through the post to the following addresses respectively:

(*a.*) In the case of the Board of Trade, the office of the Board of Trade;

(*b.*) In the case of the Postmaster-General, the General Post Office;

(*c.*) In the case of any County Council, the office of such Council;

(*d.*) In the case of any local authority, the office of such local authority;

(*e.*) In the case of the undertakers or any other company having a registered office, the registered office of the undertakers or such company.

(*f.*) In the case of a company having an office or offices, but no registered office, the principal office of that company.

(*g.*) In the case of any other person, the usual or last known place of abode of such person.

Where any notice is served by post, it shall be deemed to have been served at the time when the letter containing the notice would be delivered in the ordinary course of post, and in proving such service it shall be sufficient to prove that the letter containing the notice was properly addressed and put into the post.

A notice, order, or document by this order required or authorised to be served on the owner or occupier of any premises shall be deemed to be properly addressed if addressed by the description of the "owner" or "occupier" of the premises (naming the premises) without further name or description.

A notice, order, or document by this order required or authorised to be served on the owner or occupier of premises may be served by delivering the same, or a true copy thereof, to some person on the premises, or if there is no person on the premises to whom the same can with reasonable diligence be delivered, by fixing the notice on some conspicuous part of the premises.

Subject to the provisions of this order as to cases of emergency, where the interval of time between the service of any notice or document under the provisions of this order and the execution of any works, or the performance of any duty or act, is less than seven days, the following days shall not be reckoned in the computation of such time: that is to say, Sunday, Christmas Day, Good Friday, any Bank Holiday under and within the meaning of the Bank Holiday Act, 1871, and any Act amending that Act, and any day appointed for public fast, humiliation, or thanksgiving.

Revocation of Order.

66. If at any time after the commencement of this order the local authority make a representation to the Board of Trade that the undertakers have made any default in executing works or supplying energy in accordance with the terms of this order, and that such default is in consequence of the insolvency of the undertakers, and that by reason of such insolvency the undertakers are unable fully and efficiently to discharge the duties and obligations imposed upon them by this order, the Board of Trade shall enquire into the truth of such representation, and if upon such enquiry they are satisfied of the truth of such representation they may, after considering any further representations of the local authority, revoke this order as to the whole, or with the consent of the undertakers, as to any part of the area of supply:

67. If at any time after the commencement of this order the undertakers represent to the Board of Trade that the undertaking cannot be carried on with profit, and ought to be abandoned, the Board of Trade shall enquire into the truth of such representation, and if upon such enquiry they are satisfied of the truth of such representation they may, if in their discretion they think fit, revoke this order as to the whole or (with the consent of the undertakers and of the local authority) as to any part of the area of supply.

68. In addition to any other powers which the Board of Trade may have in that behalf, they may revoke this order at any time with the consent and concurrence of the undertakers and the local authority upon such terms as the Board of Trade may think just.

69. If the Board of Trade at any time revoke this order as to the whole or any part of the area of supply, under any of the provisions of this order, the following provisions shall have effect:

(*a.*) The Board of Trade shall serve a notice of such revocation upon the undertakers and upon the local authority, and shall in such notice fix a date at which such revocation shall take effect, and from and after such date all the powers and liabilities of the undertakers under this order for the supply of energy within such area, or part thereof as aforesaid, shall absolutely cease and determine.

(*b.*) Within two months after the service of such notice by the Board of Trade upon the local authority, the local authority, if they think fit, may, by notice in writing, require the undertakers to sell, and thereupon the undertakers shall sell to them, so much of the undertaking, or such part thereof as aforesaid as is within the district of the local authority, upon terms of paying the then value of all land, buildings, works, materials, and plant of the undertakers suitable to and used by them for the purposes of the undertaking or such part thereof as aforesaid, such value being agreed or estimated in manner directed by the Electric Lighting Act, 1888, in the case of purchases effected by the local authority under section 2 of that Act.

(c.) Where any purchase is so effected, the undertaking, or part thereof so purchased, shall vest in the local authority, freed from any debts, mortgages, or similar obligations of the undertakers or attaching to the undertaking; and the revocation of this order, as to the whole of the area of supply, or such part thereof as aforesaid, shall extend only to the revocation of the rights, powers, authorities, duties, and obligations of the undertakers from whom the undertaking, or such part thereof as aforesaid, is purchased in relation to the supply of energy within such area or part thereof, and, save as aforesaid, this order shall remain in full force within such area or part thereof in favour of the local authority, by whom such undertaking or part thereof is purchased as aforesaid.

(*d.*) Where no purchase has been effected under the preceding provisions of this section, the local authority, and any body or person who may be liable to repair any street or part of a street in which any works of the undertakers may have been placed, may (subject, however, to any agreement between the local authority or such body or person and the undertakers providing for the removal of such works by the undertakers) forthwith remove such works with all reasonable care, and the undertakers shall pay to the local authority, or other such body or person as aforesaid, such reasonable costs of such removal, and of the reinstatement of such street or part of a street as may be specified in a notice to be served on the undertakers by such local authority or other body or person, or (if so required by the undertakers, within one week after the service of such notice upon them) as may be settled by arbitration.

If the undertakers fail to pay such reasonable costs as aforesaid within one month after the service upon them of such notice, or the delivery of the award of the arbitrator (as the case may be), the local authority, or other such body or person as aforesaid may, without any previous notice to the undertakers (but without prejudice to any other remedy which they may have for the recovery of the amount), sell and dispose of any such works as aforesaid, either by public auction or private sale, and for such sum or sums and to such person or persons as they may think fit; and may, out of the proceeds of such sale, pay and reimburse themselves the amount of the costs so specified or settled as aforesaid and of the costs of sale, and the balance (if any) of the proceeds of the sale shall be paid over by them to the undertakers.

(*e.*) In case the local authority or any body or person may be entitled to any compensation for any damage sustained by them by reason or in consequence of the execution of any works within such area, or part thereof as aforesaid, or the exercise of any powers by this order granted to the undertakers, or for any expenses to which such local authority, body, or person may have been put in removing any works of the undertakers within such area or part thereof under the provisions of this order, such compensation shall be a first charge on any money that may have been deposited or secured by the undertakers under the provisions of this order in respect of such area or part thereof, and which may not have been repaid or released to the undertakers, and such money shall be applied rateably in satisfying such claims, and in every such case the amount of compensation to be paid in respect of the various claims and the persons to whom it is to be paid, shall be determined by an arbitrator, to be appointed by the Board of Trade, whose decision shall be final and binding on all parties.

GENERAL.

70. If at any time it appears to the local authority or the Board of Trade (*a*) that the undertakers are supplying energy by means of a system not approved by the Board of Trade; or (*b*) that any electric lines or works of the undertakers are defective, so as not to be in accordance with the provisions of this order or the regulations and conditions subject to which the undertakers are for the time being authorised to supply energy under this order; or (*c*) that the undertakers' works or their supply of energy is attended with danger to the public safety, the Board of Trade may, if they think fit, by order in writing, require the undertakers to remedy the same so as to comply with such order within such period as may be therein limited in that behalf, and if the undertakers make default in complying with the order within the time so limited they shall be liable to a penalty not exceeding £20 for every day during which such default continues.

Provided that where the matter so required to be remedied is, in the opinion of the local authority or the Board of Trade, dangerous to public safety, the Board of Trade may if they think fit by any such order as aforesaid forbid the use of such electric line or work as from such date as may be specified in that behalf until the order is complied with, and if the undertakers make use of any such electric line or work while the use thereof is so forbidden they shall be liable to a penalty not exceeding £100 for every day during which such user continues.

Provided also that if the undertakers supply energy by means of a system not approved by the Board of Trade, and fail to comply with any such order in respect thereof within the period limited in that behalf, the Board of Trade may, if they think fit, revoke this order upon such terms as they may think fit.

71. All regulations and conditions made by the Board of Trade under this order or the principal Act affecting the undertaking and for the time being in force, shall within one month after the same, as made or last altered, have come into force, be printed at the expense of the undertakers, and true copies thereof, certified by or on behalf of the undertakers, shall be kept by them at their principal office within the area of supply, and supplied to any person demanding the same at a price not exceeding 6d. for each copy.

If the undertakers make default in complying with the provisions of this section they shall be liable to a penalty not exceeding £5, and in case of continuing offence to a further penalty not exceeding £5 for every day during which such default continues.

72. Where any security is required under this order to be given to or by the undertakers, such security may be by way of deposit or otherwise, and of such amount as may be agreed upon between the parties, or as in default of agreement may be determined, on the application of either party, by a court of summary jurisdiction, who may also order by which of the parties the costs of the proceedings before them shall be paid, and the decision of the said court shall be final and binding on all parties: Provided that where any such security is given by way of deposit the party to whom such security is given shall pay interest at the rate of £5 per centum per annum on every sum of 10s. so deposited for every six months during which the same remains in their hands.

73. All things required or authorised under this order to be done by, to, or before the Board of Trade, may be done by, to, or before the president or a secretary or assistant secretary of the Board.

All documents purporting to be orders made by the Board of Trade and to be sealed with the seal of the Board, or to be signed by a secretary or assistant secretary of the Board, or by any person authorised in that behalf by the President of the Board, shall be received in evidence, and shall be deemed to be such orders without further proof, unless the contrary is shown.

A certificate, signed by the President of the Board of Trade, that any order made or act done is the order or act of the Board, shall be conclusive evidence of the act so certified.

74. All costs and expenses of or incident to any application for any approval, consent, or order of the Board of Trade, including the cost of any tests which may be required to be made by the Board of Trade for the purpose of determining whether the same should be given or made, to such an amount as the Board of Trade shall certify to be due, shall be borne and paid by the applicant or applicants therefor: Provided always, that where any approval is given by the Board of Trade to any plan, pattern, or specification, they may require such copies of the same, as they may think fit, to be prepared and deposited at their office at the expense of the said applicant or applicants, and may from time to time, as they think fit, revoke any approval so given, or permit such approval to be continued, subject to such modifications as they may think necessary.

75. Where the Board of Trade, upon the application of the undertakers, give any approval or grant any extension of any time limited for the performance of any duties by the undertakers, or where the Board of Trade, upon the application of the local authority or the undertakers, revoke this order as to the whole or any part of the area of supply, notice that such approval has been given, or such extension of time granted, or such revocation made, shall be published by public advertisement once at least in each of two successive weeks in some one and the same local newspaper by the body by whom such application was made as aforesaid.

76. Where any application is made to the Board of Trade to extend any time limited for the performance of any duties by the undertakers, notice of such application shall be served on the local authority by the undertakers, and an opportunity shall be given to the local authority to make representations or objections with reference thereto.

77. All penalties under this order, or under any regulations made under this order or the principal Act, the recovery of which is not otherwise specially provided for, may be recovered in a summary manner before a court of summary jurisdiction.

Any such penalty recovered on prosecution by an officer of the local authority shall, if there is an electric inspector for the time being appointed by the local authority, be paid to such officer and by him to the local authority, and shall be applied in aid of the local rate.

Any such penalty recovered on prosecution by any other body or person, or any part thereof, may, if the court shall so direct, be paid to such body or person.

78. The undertakers shall be answerable for all accidents, damages, and injuries happening through the act or default of the undertakers or of any person in their employment by reason of or in consequence of any of the undertakers' works, and shall save harmless all authorities, bodies, and persons by whom any street is repairable, and all other authorities, companies, and bodies collectively and individually, and their officers and servants from all damages and costs in respect of such accidents, damages, and injuries.

79. Nothing in this order shall prevent the undertakers borrowing money on the security of mortgages of the undertaking, or shall make the consent or approval of the Board of Trade necessary to the validity or effect of any such mortgage: Provided that every mortgage of the undertaking shall be deemed to comprise all purchase-money which may be paid to the undertakers in the event of any sale or transfer of the undertaking, or any part thereof, under section 2 of the Electric Lighting Act, 1888, or under this order, and that any mortgage granted by the undertakers shall not be a charge upon the undertaking, or any part thereof, in the event of the undertaking or such part being sold or transferred as aforesaid, and that every mortgage deed granted by the undertakers shall be endorsed with notice to that effect.

80. Nothing in this order shall affect any right or remedy of the Postmaster-General under the principal Act or the Telegraph Acts, 1863 to 1885, and all provisions contained in this order in favour of the Postmaster-General shall be construed to be in addition to and not in modification of the provisions of those Acts.

81. Nothing in this order shall authorise the undertakers to take, use, or in any manner interfere with any portion of the shore or bed of the sea, or of any river, channel, creek, bay, or estuary, or any right in respect thereof belonging to the Queen's most excellent Majesty in right of her Crown, and under the management of the Board of Trade, without the previous consent in writing of the Board

of Trade on behalf of Her Majesty (which consent the Board of Trade may give), neither shall anything in this order contained extend to take away, prejudice, diminish, or alter any of the estates, rights, privileges, powers, or authorities vested in or enjoyed or exerciseable by the Queen's Majesty.

82. Nothing in this order shall authorise the undertakers to interfere in any manner with the bed or shore of the River ———, or the navigation thereof, or affect in any manner the rights, powers, or privileges of the conservators of the River ———.

83. Nothing in this order shall exonerate the undertakers from any indictment, action, or other proceedings for nuisance in the event of any nuisance being caused by them.

84. Nothing in this order shall exempt the undertakers or their undertaking from the provisions of or deprive the undertakers of the benefits of any general Act relating to electricity, or to the supply of or price to be charged for energy, which may be passed after the commencement of this order.

PROVISIONAL PATENTS, 1890.

May 19.

7756. **Signalling by flashing a light contained in a portable lantern which can be used for electric light or oil.** Swinton C. Holland, Bredon, Foster-road, Gosport.

May 20.

7819. **Timing the arrival of a homing pigeon by electrical means.** George Jesse Larner, Darenth, near Dartford, Kent.

7836. **Improvements in electric semaphores for railways.** Frederick Stitzel, Charles Weinedel, Moses J. Schwartz, Adolph Reutlinger, John Henry Egelhoff, and Jacob Kreiger, 70, Wellington-street, Glasgow. (Complete specification.)

7853. **Improvements in welding metals electrically, and apparatus therefor.** William Phillips Thompson, 6, Lord-street, Liverpool. (Charles L. Coffin, United States.) (Complete specification.)

7867. **Improvements in electric motors.** Henry Harris Lake, 45, Southampton-buildings, London. (The Giant Electric Motor Company, United States.) (Complete specification.)

7871. **Improvements in electrical signal circuits.** Orlando Wilson Hart, 45, Southampton-buildings, London. (Complete specification.)

7876. **Improvements in methods of and apparatus for melting, refining, and casting metals and other substances by electricity.** Henry Harris Lake, 45, Southampton-buildings, London. (Edward Allen Colby, United States.) (Complete specification.)

May 22.

7902. **Improvements in recording measuring apparatus, also applicable to signalling and telegraphic instruments.** Frank Benjamin Lea, 4, Moorfields, London.

7932. **Improvements in mandrils for electrolytically deposited tubes.** Francis Edward Elmore, 28, Southampton-buildings, London.

7981. **Improvements in dynamos and electro motors.** Emile Sechehaye, 28, Southampton-buildings, London.

7988. **Improvements in welding metals electrically.** Charles L. Coffin, 6, Lord-street, Liverpool. (Date applied for under Patents Act, 1883, Section 103, 6th November, 1889, being date of application in United States.) (Complete specification.)

7989. **Improvements in welding metals by electricity.** Charles L. Coffin, 6, Lord-street, Liverpool. (Date applied for under Patents Act, 1883, Section 103, 12th November, 1889, being date of application in United States.) (Complete specification.)

7990. **Improvements in electric welding.** Charles L. Coffin, 6, Lord-street, Liverpool. (Date applied for under Patents Act, 1883, Section 103, 19th November, 1889, being date of application in United States.) (Complete specification.)

7991. **Improvements in electric welding.** Charles L. Coffin, 6, Lord-street, Liverpool. (Date applied for under Patents Act, 1883, Section 103, 19th November, 1889, being date of application in United States.) (Complete specification.)

7992. **Improvements in electric welding.** Charles L. Coffin, 6, Lord-street, Liverpool. (Date applied for under Patents Act, 1883, Section 103, 19th November, 1889, being date of application in United States.) (Complete specification.)

7993. **Method of welding metals electrically.** Charles L. Coffin, 6, Lord-street, Liverpool. (Date applied for under Patents Act, 1883, Section 103, 6th December, 1889, being date of application in United States.) (Complete specification.)

7994. **Method of welding metals electrically.** Charles L. Coffin, 6, Lord-street, Liverpool. (Date applied for under Patents Act, 1883, Section 103, 12th December, 1889, being date of application in United States.) (Complete specification.)

8031. **Improvements in and relating to printing-telegraphs, and to the distribution of news transmitted thereby.** Robert Dunbar Radcliffe, 45, Southampton-buildings, London.

May 23.

8036. **An improved insulated electric conductor.** Robert William Eddison, 47, Lincoln's-inn-fields, London. (George Niemetz, Austria.)

8076. **Improvements in the distribution of electric energy.** George Wilkinson, 95, Hubert-grove, Stockwell, London.

8086. **Improvements in secondary batteries.** Mark Bailey and John Warnes, 21, Finsbury-pavement, London.

8110. **Improvements in electric regulators and meters of which such regulators form a part.** George Forbes, 24, Southampton-buildings, London.

May 24.

8114. **Improvements in electric light fittings.** George Parfitt, Keynsham, Bristol.

8115. **Improvements in electric light fittings.** George Parfitt, Keynsham, Bristol.

8116. **Improved handles for electrical switches.** Gustav Binswanger and Gustav Franke, 71, Queen Victoria-street, London.

8141. **A new electric lamp.** Horace George Nichols, Broomsgrove, Brentwood.

8153. **Improvements in or appertaining to the charging and working of accumulators of electric light installations and the like.** Arthur Bromley Holmes, 6, Lord-street, Liverpool.

8172. **An improved governor and apparatus in connection therewith, for the automatic regulation of motors in which a difference of level potential pressure or weight is used to produce motion and power.** Alfred George Melhuish, 39, Grove-hill-road, Denmark Park.

SPECIFICATIONS PUBLISHED

1889.

7774. **Supplying electric current to road vehicles, &c.** Sayer. 8d.

9182. **Telephonic circuits.** Graham. 11d.

9183. **Electric batteries.** Sussmann. 4d.

9294. **Dynamo electric machines.** Lake (Bradley). 1s. 1d.

10440. **Incandescent electric lamps.** Bayley. 8d.

10556. **Electric cable.** Gray. 6d.

10699. **Electrical lamps.** Siemens Bros. and Co., Limited (Siemens and Halske). 8d.

11049. **Dynamo-electric machines.** Wood. 1s. 1d.

19129. **Electric batteries.** Bonne (Meinecke). 4d.

1890.

4407. **Electric railways.** McGrew. 8d.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The receipts for the week ended May 23 amounted to £4,617.

Electric and General Investment Company, Limited.—Letters of allotment in this Company have been posted.

Western and Brazilian Telegraph Company.—The receipts of this Company for the past week, after deducting the "fifth" payable to the London Platino-Brazilian Company, were £3,584.

Spanish Telegraph Company.—The numbers are announced of 76 debentures, amounting to £7,600, of the Spanish National Submarine Telegraph Company, Limited, 6 per cent. mortgage debentures, drawn for repayment on and after June 30th, at the National Bank of Scotland, Limited, 37, Nicholas-lane, E.C.

Consolidated Telephone Construction and Maintenance Company, Limited.—The report of this Company for the year ending March 31, 1890, shows a net profit of £12,714, which, with the amount carried forward from last year, leaves a balance of £14,273 for disposal, after making provision for doubtful debts. The Directors propose to deal with this amount as follows—viz., to pay a further dividend of £7 per cent. for the half-year on the ordinary shares, and £6 per cent. on the preference shares, making with the interim dividend paid in November last, £6 per cent. for the year on both descriptions of shares; writing off the sum of £543 for depreciation of plant, machinery, and furniture; and the sum of £2,000 from the Edison Gower-Bell Telephone Company's securities, thus leaving a balance of £1,843 to carry forward. During the year the Directors have received a further and final payment of £486 on account of profit arising from the liquidation of the River Plate business, which is included in the above statement.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Anglo-American Brush	—	2¼
— Pref.	—	1¾
India Rubber, Gutta Percha & Telegraph Co.	10	18
House-to-House	4½	5
Metropolitan Electric Supply	—	5¾
London Electric Supply	5	2½
Swan United	3½	5
Crompton & Co., Pref.	—	5½
National Telephone	5	5¼

NOTES.

Bremen.—A great industrial exhibition has been opened at Bremen.

Extension in Liverpool.—An application for a large extension of the area of supply in Liverpool will probably be granted.

Birmingham.—The electric light station for Birmingham central district is being commenced, and will be pushed forward rapidly.

Popular Electrics.—The great Scotch papers, when instructing the public idea, might at least see that Faraday's name was given correctly.

Vienna Exhibition.—Most of the principal electrical companies in Vienna are complying with the regulations of the forthcoming Vienna Exhibition.

Chicago.—The contract for 100,000ft. of 2in. steel pipe for electric conduits for Chicago, has been lately given out to Messrs. Clow and Son, Chicago, for 10,800dols.

Austria.—The electric light has been fitted in the villa of the Empress of Austria at Lainz, and will shortly be also installed in the summer residence of the Emperor at Ischl.

Dry Batteries.—One cell of a dry battery, known as the King Philip, is reported as having run a 6in. gong for 65 days continuously with no apparent diminution of its powers.

Litigation.—The electric tramway case between Mr. Elieson and Messrs. Crompton has been before the Courts this week. It was adjourned yesterday, and will probably be concluded to-day.

Coming and Going.—"The electric cars were unconscionably slow in coming," was the remark anent the new electric tramway in a western town, "but they are like greased lightning for going."

Fleetwood.—Their Bill having passed, the Fleetwood Commissioners are now in a position to light the town with electricity, or make terms with any company that would like to possess such power.

Enamelled Iron.—The Imperial Enamel Company have commenced manufacture at Watery-lane, Birmingham, of impervious enamelled iron goods of all kinds, some of which may be useful in electrical work.

Electric Heating.—At a recent exhibition at Chicago a special feature was made of electric heating apparatus. Among other novelties were a soldering iron, a tailor's goose, a flat iron, an egg boiler, and an oven, all heated electrically.

Paris.—The Continental Edison Company are erecting large ornamental lampposts, carrying arc lights, on the sidewalks of the Grand Boulevards. The lamps placed down the centre of the roadway were found not to give sufficient light on the pavement.

The Lord Mayor's Electric Coach.—The progress of the Lord Mayor in his official visit to the Edinburgh Electrical Exhibition is to be commenced characteristically in a ride from the Mansion House to the railway station in Ward's electrical omnibus.

Light and Power.—After months of negotiation all the street railway companies of Richmond, Virginia, and the three electric light companies have amalgamated, presumably with the idea of supplying light and power to all around under one organisation.

Electric Power.—The Daft electric power station, Newark, New Jersey, supplies motors to the aggregate of 150 h.p. Some of the motors are over two miles away from the station. The company is prepared to furnish motors from ½ h.p. up to 50 h.p.

Vienna Tramways.—At Vienna, the amalgamation is announced of one of the railway companies and an electric tramway company, for working lines common to both by electric traction. Vienna will soon possess the longest electric railway in Europe.

Woking.—The Board of Trade have issued a provisional order to the Woking Electric Light Company, and copies of the order have been deposited for public inspection at the offices of the company, and at the office of Guildford Sanitary Authority, and elsewhere.

Elevated Electric Railway.—The West End Electric Railway of Boston, U.S., have received a charter to build an elevated electric railway. Three years are allowed to build it. Inclined planes and electric traction are stipulated for, and the fare must not exceed 2½d.

Electric Welding.—It is announced that the U.S. Government have given contracts for 100,000 projectiles for Hotchkiss and Shrapnell guns, to be manufactured on the process invented by Lieutenant Wood, in which the Thomson-Houston welding machines are used.

Personal.—Mr. Frank B. Lea, B.A., A.I.E.E., who has exerted himself so vigorously and genially as editor and manager of *Electrical Plant*, has now ceased all connection with this journal, and is about to take up more active practical work in the way of electric transmission of power.

Boston Tramcars.—There are probably more electric cars in Boston, U.S., than in any other town. The wires are overhead, and no one is understood to complain about them. Capitalists are pulling in more money and projecting more lines, and Bostonians will soon have all the rapid transit they want.

Overhead Storage Cars.—The elevated railway at Sioux City, Indiana, will be an interesting work both to city authorities and electrical engineers. It will be an overhead storage car railway. The columns are 18ft. apart, and the road-bed will be 22ft. above the street. On the top of this rails will be laid and electric storage cars are to be run on these.

Indian Telegraphs.—In connection with the prevailing distress in parts of Garhwal, it is reported that a new telegraph line will almost immediately be commenced as a famine work. The line will run from the new cantonment of Kaladanda to Pauri, and thence on to Srinagar, a total distance of about 40 miles.

Motors.—To the end of last year the Hydraulic Power Company had 1,022 motors working in London, and a dividend of 5¼ per cent. was paid. This kind of work, and a great deal more of it, may be done by electric motors, so electric motor men may as well be beginning to get their motors in as soon as possible.

Preston.—The negotiations with regard to obtaining powers for electric lighting at Preston have not progressed so favourably as could be desired. The town clerk has been to London to confer with the Board of Trade to see if a final arrangement could be come to, but awkward difficulties were expected to be encountered.

Agra Water Works.—A steady subsidence is noticed of the waters of the Jumna at Agra. The snows last winter have been lying 2,000ft. above normal height, and the delay in melting is causing grave apprehension. The water works at Agra are being pushed forward, electric light is utilised, and labour is being continued far into the night.

Ventilating Conduits.—The Chicago city electrician has, by making connections with the City Hall chimney, caused a draught from the city conduits that relieves them of all gases, and prevents the manhole explosions that have been so frequent of late. The Commissioner of Public Work recommends this plan to all underground companies.

Platinum.—The demand of the electrical industry for platinum is making that already precious metal more precious. The price, it is announced, has already risen 100 per cent. in value within the last year, and it is expected to continue in its upward course, never, perhaps, to be cheaper. It would be a small fortune to the chemist who could provide a substitute.

Contracting.—Mr. F. Geere Howard notifies us that, in consequence of the great increase in his contracting work, he has disposed of his manufacturing business to Messrs. Appleton, Burbey, and Williamson, and intends to devote himself entirely to the former, having a great amount of work in hand. He has also removed to more spacious premises at 18, Berners-street, W.

Dick, Kerr and Co.—Messrs. Dick, Kerr and Co., the well-known tramway contractors, have been converted into a limited company, with a capital of £160,000. If they had taken up electric traction, and could show good contracts and results, we should have better liked to see it so. Steam traction for tramcars is very nearly played out, though the construction of tramway lines remains.

Dublin Gas.—A motion has been carried by the Dublin Corporation that the Gas Committee enquire into and report upon all the circumstances connected with the increase of gas in Dublin, and that the committee so constituted be empowered to obtain and pay for such professional assistance as they may require for their investigation, and pay such expenses as may be necessary for the purposes of the enquiry.

Southend Pier.—At the meeting of the Southend Local Board, a letter was received from Dr. Hopkinson asking the Board to fix site for the temporary engine and dynamo. Mr. Wood suggested a site underneath the bridge across the esplanade, close by the eastern entrance to the tramway terminus. This was agreed to, and Messrs. Allen, Ingram, and Wood were appointed a committee of selection should alteration be required.

Water Power Tramways.—An exclusive electric street railway franchise has been granted at La Grande, Oregon, for 30 years, work to commence on or before June 10, 1890, and some part of the road to be in operation in November, 1890. The road is to extend from Oro Dell to the old town, through the principal streets of the new town, and it is understood that the Oro Dell water power, in the Grand Ronde river, is to be used to furnish the power.

Electric Railways.—Electric tramways are developing more and more into electric railways, and communication between town and town is now not unknown in the States. We notice that several New York capitalists have been granted a franchise to build an electric railroad between *Orange* and Athol, Massachusetts, and propose to begin work immediately. The Daft double trolley system will be used, and the company are to have the road in running order by July.

Electric Bludgeons.—We notice the Dublin papers are still giving a description of an "electric bludgeon," the size of a cigar, which by simply pointing it at a man can shock him into insensibility and so allow him to be robbed or taken prisoner. Why do not these papers, before giving such items as anything more than a joke, take the advice of someone who knows a little about electricity, and not spread such absurd items as truth ?

Ipswich.—At the meeting last week of the Ipswich Paving and Lighting Committee, a communication was read from the Brush Electrical Engineering Company notifying that in consequence of a technical irregularity in the form of notice given the Board of Trade had decided not to deal with their application for an order this year. Therefore the company would not be able to take steps to provide electric light for the present, but intended to renew the application in proper form for next session.

Electric Car Statistics.—It is worthy of note that the four cars of the Electric Traction Co. running on the Barking-road for the North Metropolitan Tramway carried on Whit Monday 8,689 passengers; an average of 2,172 per car, and earned £9. 1s. each. Taking into account the short mileage, such an average is far above the possibilities of horse cars. During the three days, Saturday, Sunday, and Monday, 20,104 passengers were carried, and this we understand is the highest record of the tramway company.

Tenders for Brussels.—We have received from the Municipality of Brussels the form, with conditions of tender, and conditions of working for the supply of electric current for the town of Brussels. This form enters fully into the conditions imposed, and stipulates besides the amount of depreciation of the various machinery. The tenders are to be sent to the Secretary of the Hotel de Ville, Brussels, and must arrive before August 1st next, at noon. We shall give a full translation of the whole form next week.

Berrenberg Pump.—The Beacon Vacuum Pump Company has been organised in Boston, U.S., to manufacture the Berrenberg mechanical vacuum pump, of which we lately gave some description. The company have four 16-c.p. lamps exhausted by their pump in 10 minutes that have been burning constantly for 1,368 hours, and are apparently as good as ever. The main feature of this pump is that the several cylinders are surrounded by a vacuum jacket, which enables practical success to be obtained with mechanical methods of exhaustion.

Exeter.—At a meeting of the Exeter City Council last week, a letter was read from the solicitor to the Exeter Electric Light Company, giving formal notice that the company intend to apply to the Board of Trade for a provisional order authorising the company to supply electricity within the city and county of Exeter. As the company was a local one, in which a considerable amount of local capital had been embarked, and it was already in active work, and supplying electricity to a large number of citizens, the directors hoped the Council would support the proposed application, especially as, until the company possessed powers to break up streets, it would be impossible for them to put the wires underground. The matter was referred to the Parliamentary Committee.

Propaganda.—A neat and handy little pamphlet has been issued by Messrs. W. O. Rooper and Tozer, Greengate-street, Stafford, upon methods of installation of electric light adopted by them, for distribution to intending clients. This little book not only contains explanatory matter about electricity and electric light itself, but it contains illustrations of actual arrangements adopted in certain mansions already fitted by the firm, showing dynamos, battery-rooms, switchboards, fittings, etc., in a manner that both gives at the same time a definite idea and a good reference. The various arrangements are somewhat fully explained in a sufficiently popular manner, and details of cost, and also answers to objections that may be raised, make this little book a very useful one for commercial propaganda.

Electric Welding.—We believe we are correct in stating that the electric welding company which has been in the air for the last few months will be before the public next week. We are glad to be able to be assured that the ratio of the purchase price from the American owners of this undoubtedly valuable process to the capital is not quite so large as was at first rumoured—certainly a matter for congratulation, as all electrical engineers are watching with interest and impatience for the practical application of this new and useful branch of electrical processes. We understand that some delay has been occasioned by the arrival of the mechanical drawings of the machines, but that arrangements are now practically complete for the manufacture of all types of welders in the North of England.

Conduits in New York.—Subsidiary electrical conduits, extending from the main conduit to the kerb of the pavement, are just now a lively subject of discussion between the Commissioner of Works of New York and the Subway Commissioners' engineer. The latter claims that such connections would be very expensive, and that it is absolutely necessary to be able to reach the main cable. Mr. Gilroy, commissioner of works, says that a Bill is now in the hands of the Governor of New York which compels the subway company to make these connections, and further provides that the Commissioners of Works can make them at the expense of the company. Mr. Gilroy denies that pavement can be relaid so as to be as good as when first put down; and the experience in New York is held to justify his adverse opinion.

Blowing up a Wall.—The removal of the old dock wall at the Royal Albert Docks was recently described by Mr. Joseph Thomas, who undertook the work. The basin, which it was found necessary to enlarge, was surrounded by a concrete wall hard as granite, 38ft. deep, 20ft. wide at the bottom, and 5ft. at the top. Several schemes were proposed, but that finally selected was by explosives fired electrically. The effect of closing the circuit was remarkable. The entire visible length of wall was instantaneously lifted in the air in a perfect line about 6ft., a crackling roar, a cloud of brownish smoke, and a violent surface displacement of the water in the immediate neighbourhood of the wall was the only visible effect of the vast forces let loose below. So instantaneous was the effect that the chairman of the dock company, who closed the circuit, declared the wall fell to pieces before his hand struck the switch.

Public Installation for Bridlington.—A special meeting of the Bridlington Local Board was held last week to consider the question of lighting the Prince's-parade with electric light. Messrs. Laing, Wharton, and Down had offered to light the parade for 12 weeks for the sum of £50, they to find the dynamos, lamps, an attendant, etc., and the Local Board to supply the motive power. The question was referred to the Lighting Committee, who now reported that they had gone fully into the matter, and had been in communication with Messrs. Laing, Wharton, and Down, and they recommended the Board to accept the offer contained in their letter. Dr. Redman, chairman of the Lighting Committee, moved the confirmation of the committee's report, which was adopted unanimously. It was further resolved that the Building and Lighting Committee take the necessary steps to cause the Prince's-parade to be lighted with electricity.

Duration of Lamps.—According to the results obtained at the theatre of Magdeburg, the German Edison incandescent lamps do not seem to have a very long life. With 40 lamps placed on trial, for five of these the life was 66, 433, 483, 515, and 595 hours, while for the 35 others the hours varied between 518 and 643. The average life of these lamps, therefore, seems to be about 600 hours. Meanwhile we have a different account from the States, given by Mr. McCormick, of the Edison station at Westchester, Pennsylvania. He reports a lamp—Edison 16 c.p. of 106 volts—which has burned every night from sunset to sunrise from February 19, 1886, to March 20, 1890, which is 1,125 days. Reckoning on a basis of average burning period of 10 hours a day, this gives to the lamp a life of 11,250 hours. Mr. McCormick also reports lamps burning nightly ever since the spring of 1887, showing, it is thought, that the incandescent lamp is undergoing a great improvement in methods of manufacture.

St. Pancras Installation.—St. Pancras is going ahead sharp. The advertisement for tenders, as will be seen in another column, is already out, drawings and specifications being on view at Prof. Robinson's, 13, Victoria-street, and the tenders are to be lodged by the 23rd June next. It was only at the last weekly meeting of the London County Council on Tuesday that it was resolved, on the recommendation of the Finance Committee, that subject to all necessary consents, the application should be granted of the Vestry of St. Pancras for a loan of £10,000 to enable them to purchase a site for an electrical installation between Stanhope-street and Laxton-place. The site contains an area of 21,000 square feet. The loan is granted on condition that it be taken up at once, interest being charged at the rate of £3. 10s. per cent. per annum, and the principal being repaid by equal annual instalments within a period of 50 years. We shall evidently see St. Pancras lighted up before much time is lost.

Leeds Exhibition.—A correspondent sends us some particulars of the Leeds Electrical Exhibition, which, if specially interesting to the district, is also of interest to electrical folk. Although several exhibitors have not yet brought in their wares owing to part of the glass roofing having been delayed by reason of a strike in the glass trade, yet there are a few good things to be seen, whilst a full programme of music and other amusements is provided. The well-known dynamo makers Messrs. Blakey, Emmott, and Co. are supplying the dynamos for electric lighting of the buildings. Mr. A. W. Bennett, of Leeds, is showing a complete gas-engine installation of incandescent lighting, including his own make dynamo machine, and "Leeds" gas-engine by Mr. J. R. Woodhead, his main switchboard, etc., also his special mining bells. Mr. J. Oliver, of Leeds, and Mr. Boardman, of Bradford, show electromotors, and watchman's clocks, indicators, etc. Bells, indicators, etc., are also shown by other exhibitors, including the Leeds Electric

Supply Company. Altogether it might be worth while for some of our readers who are northward inclined to break the journey between Edinburgh and the South so as to also to take in the Leeds Exhibition.

Electric Omnibus.—The death of Colonel McMurdo, who took a great interest in the development of Mr. Ward's electric omnibuses, has caused delay and difficulty in the completion of the undertakings, but we understand that arrangements are practically completed with the Electric Construction Corporation to construct either six or twelve electric omnibuses to ply from Charing Cross to King's Cross. The Electrical Omnibus Company will, according to a recent circular, be reconstituted under its present name, the shares of the original company issued as fully paid, being open for purchase partially or as a whole, and subsidiary companies will, it is thought, if the venture prove a success, be organised in some of the various principal cities at home and abroad. Mr. Ward has also recently patented an application of electric traction to the celebrated sliding water railway, which, if the latter is ever adopted practically, may prove to be a more practical method of propulsion than the water-jet method.

Photographing Underground.—The use of electricity enabled a photograph to be taken recently under most exceptional and difficult conditions. A landslide occurred at a quarry in France, and a large number of workmen were buried in the subterranean gallery. It was supposed that the men were entombed in one of the galleries about 220ft. below the mouth of the mine; but nothing certain was known of their position, and for an attempt at rescue to have any chance of success an approximate idea of their whereabouts had to be gained. The difficulty was surmounted by sinking a shaft about a foot in diameter, in the direction of the gallery, and through it lowering, by means of a chain, a small camera, mounted in a metallic tube. The camera was pivoted within the tube at its upper end, so that it might be fixed at any angle by tightening or slackening the connecting cord. Above and below the camera were placed rows of incandescent lamps, and when the apparatus had been lowered, the camera was made to incline outward from the case. In order to photograph the interior of the gallery all that was necessary was to turn on the current and light the incandescent lamps, the plate being exposed at the same time. In this manner excellent results were obtained from a photographic point of view, the time of exposure being five minutes.

Presentation by Messrs. Drake and Gorham.—The staff and employés of Messrs. Drake and Gorham, who now number upwards of 80, presented Mr. Bernard Drake, on the occasion of his marriage on the 28th May, with a handsome plate chest containing an assortment of silver plate. Mr. Drake, in replying, said how much he appreciated the very handsome and useful present, which he should value all the more because of the sacrifices that must have been necessary to give such a costly token of their good feeling. He alluded to the unity of interests between employer and employed, to which he had always attached great importance, and thanked them all for the very loyal way in which they had always worked for the welfare of the firm. He wished them to feel that as the business increased and prospered their individual interests were watched, and that every success scored would tend to better their own positions. The firm had a laudable object in view—viz., to do better work than anyone else, to employ better men, and pay better wages. With their assistance the policy was succeeding, and the firm was in a more prosperous condition and had more work in hand now than at any previous stage of its existence. He hoped they would continue to co-operate in executing work so that it might be a credit to all, and that they would continue to pay the closest attention to "details," for on that to a large extent success depended. He again thanked them very heartily for their kind present and good wishes.

Glasgow Central Railway.—Electrical engineers and the public have been girding at the directors of the London underground railways to try by all means possible to introduce cleanly electrical traction instead of the vile and uncivilised "sewer" of sulphurous gas, which in hot weather especially is unbearable, a fact from which the bus companies reap abundant harvest. The great difficulty is, the plant is there and working: if it were to be done over again, perhaps it might be different. Well, now is the time to turn to other fields. Glasgow is to have a brand new underground railway seven miles long. If electrical traction be so good and so cheap and so practical as we make out, now is the time to convince the railway engineers of that fact. They may or they may not fall in with the electrical engineers' ideas upon the subject, but at any rate this should be upon their own head. Full particulars should be given them and they must not be allowed to say afterwards: If only you could have proved and guaranteed such and such a thing, we would gladly enough have considered and possibly adopted your ideas. There is one fact that stands perhaps in the way of adoption of electricity at the present, the line is to be a continuation of the Caledonian Company's system. Still, it is probable special engines will be used, and if electric traction is as practical as its promoters state, this may not stand in the way, while it is manifest that for long underground lines in crowded cities electricity will eventually be the future power. The contract for the construction has been let in four parts: the Bridgeton and the Trongate contract to Messrs. C. Brand and Son, the Stobcross contract to Messrs. Jas. Young and Son, and the Kelvinside to Mr. A. H. Boyle, the total cost being £970,000. The engineers are Mr. G. M. Cunningham, M.I.C.E., Edinburgh, and Mr. Chas. Forman, M.I.C.E., Glasgow. The line for the greater part of its length is 20ft. below street level, though under Kelvin Grove Park it is nearly 100ft., then rising by 1 in 100 to clear the River Kelvin. The ruling gradient is 1 in 80 The tunnels will be from 14 to 18ft. high, and ordinary gauge will be used.

A New Type of Dynamo.—The Société des Telephones, of Zurich—a company formed in Zurich for the various applications of electricity—sends us some particulars of a new type of dynamo, which for some little time they have been constructing upon the designs of their engineer-in-chief, M. Mariotti. These are multipolar machines, with ring armature, in which what is claimed as an entirely novel magnetic arrangement is adopted. While the dynamos constructed up to the present have had electro-magnets arranged either as exterior poles or as interior poles, in the new machine both exterior and interior poles are employed, which embrace the ring armature alternately. This arrangement presents special advantages. The lines of force must absolutely take the path of the iron in the armature; a direct path between the poles is impossible. The pole-pieces embrace the largest possible surface of the armature; and they come close to the neutral line, a thing which is not practical with any other type of dynamo without prejudice to its efficiency. It is to this point that may be attributed the entire absence of sparking at the brushes, as well as the negligible displacement of the neutral line at variable load. The peculiar arrangement of the magnetic field reduces the heating of the iron in the armature produced by the action of hysteresis, to a minimum. The ventilation is the best possible, and, in general, the arrangement of the machines shows various specialities which are of great value, both for solidity and simplicity of mechanical construction. The extent of the pole-pieces is not restricted by the dimensions of the armature ring, as is the case with dynamos with interior poles. The new arrangement, moreover, allows the employment of armatures of considerable diameter without the necessity of increasing the field-magnets disproportionately, as is necessarily the case in many systems of dynamos with exterior poles. The system is advantageous for slow-speed dynamos, and especially for motors. The tests made with a 20 h.p. dynamo have thoroughly proved the advantages theoretically to be expected by this novel disposition of magnetic circuit, so much that this innovation is regarded as one of real progress in the construction of dynamos.

The Edinburgh Committee.—On Tuesday a meeting of the London Committee of the Edinburgh Exhibition was held at the Mansion House. Sir George Chubb, the chairman, presided, and among those present were Alderman Sir Francis Truscott, Sir Frederick Abel, Captain Shaw, C.B., Mr. E. N. C. Braddon (Agent-General for Tasmania), Major Flood Page, and others. On the motion of the chairman, Lord Claud Hamilton, General Lord Chelmsford, Prof. Dewar, Colonel Edis, Mr. Alderman Evans, Sir H. Trueman Wood, and others were added to the committee. Mr. S. Lee Bapty, the general manager of the exhibition, gave some particulars of the arrangements for the approaching visit of the Lord Mayor and sheriffs to Edinburgh. The civic party, which would include Alderman Sir F. Truscott, the recorder, and the town clerk, would arrive, he said, on the evening of June 19th, and be entertained the same night at dinner by the Lord Provost in the Waterloo Rooms. On Friday it was proposed that a visit to the Forth Bridge should be paid, and the Lord Provost would give a luncheon in honour of the visitors at his own residence. Afterwards the Lord Mayor and the sheriffs would drive in their state equipages to the exhibition, where they would be received by the committee in the great hall, and conducted round the exhibits. In the evening they would be entertained at dinner by the committee at the exhibition. On Saturday morning the Lord Mayor and his colleagues would be received in the Council Chamber at Edinburgh by the Corporation, and would afterwards drive round Edinburgh, dining in the evening with the Lord Provosts and Provosts of Scotland in the Waterloo Rooms. Every preparation was being made to give a warm welcome to the civic party on the occasion of their first state visit across the border. As regarded the progress of the exhibition, the visitors in the first month had numbered 470,000, which was largely in excess of his most sanguine anticipations, and was all the more remarkable considering the state of the weather during most of the month. If the same number of visitors continued each month till October there would be a total of over 4,000,000. A very important exhibit of electrical appliances from 40 manufacturers in France had just arrived, and would be on view by the time of the Lord Mayor's visit. Sir George Chubb said he hoped as many members of the London Committee as possible would be present in Edinburgh on the occasion of the civic festivities. A vote of thanks to the chairman closed the proceedings.

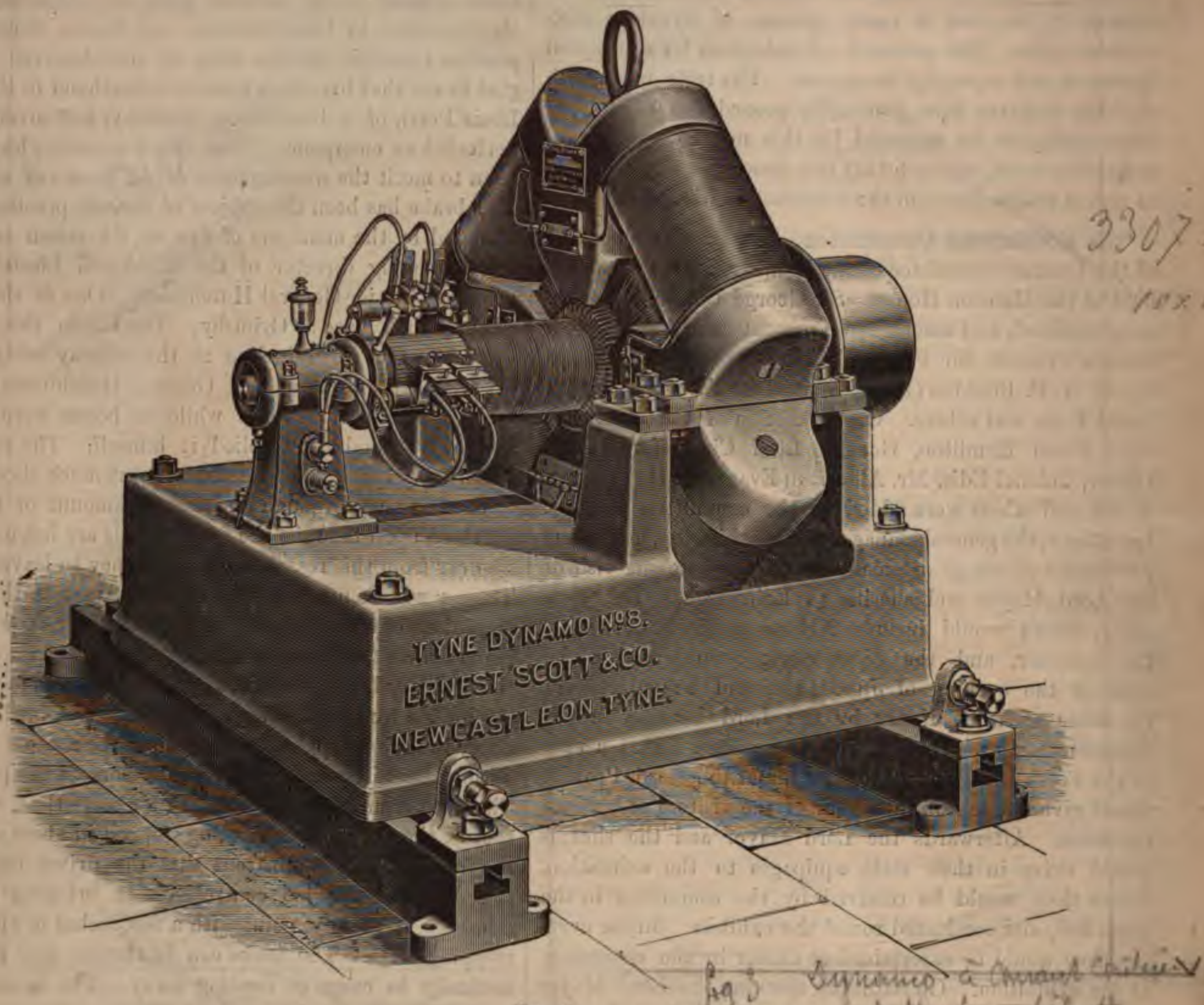
Tramcar Emergency Brake.—We may put the question to our tramway electrical engineers, would they sooner have an arrangement which would stop a car in an emergency in a yard or so, even though it jerked the passengers somewhat unceremoniously together, or have the car occasionally get beyond control and run away, possibly killing one or more persons? To ask the question is to answer it, and even if the tramway men did not prefer the first course the Board of Trade would certainly do so. A few more accidents like that recently reported from Buda-pest, where the conductor of a fatal runaway car was nearly lynched, and one or two which have arrived from various parts of America, would shortly serve to bring electric cars to an objectionable position in public opinion they do not deserve. We are glad to see that inventors are not behindhand in this. Mr. Louis Porri, of 4, Kent-street, Grimsby, has invented and perfected an emergency brake for tramcars, which would seem to merit the investigation of all tramway engineers. This brake has been the subject of various practical trials, attended by the managers of five or six steam tramways, the managing director of the Blackpool Electric Tramway, and Major-General Hutchinson. One of these trials recently took place at Grimsby. The car on this occasion was taken to a steep incline at the railway bridge, where the trials were to be made. General Hutchinson had the brake applied several times while the horses were going at a sharp trot, and also applied it himself. The stops were remarkably quick, and effected without much shock, owing to the fact that although an immense amount of friction is obtained upon the rails the front wheels are left untouched. The car from this reason has no tendency to leave the rails. The car was then taken to the steepest part of the line, on a gradient of about 1 in 20, the greatest in the town. After being drawn to the top of the hill the horses were detached, the ordinary brake released, and the car allowed to run down the incline free. When a good speed was obtained the emergency brake was applied, and brought the car to a standstill within about its own length from the moment of application. These experiments were continued for some time, at various speeds, the car sometimes being stopped in about a yard on the incline. It was apparent that the driver had the car completely under his control, either bringing it up or releasing it at any point with a few inches motion of the stopping lever. The brake can be thrown into gear automatically in cases of running away. The brake having been thoroughly tested upon the incline, the car was run over on to the level part of the line for the purpose of demonstrating the working of the "protectors," another part of Mr. Porri's invention, which are designed to remove bodies from the track in cases where a person is knocked down or falls in front of the car without being noticed by the driver. The protectors, which are of V shape, are connected with the emergency brake, so that if their spring action does not instantly remove bodies from the rails, it automatically applies the brake. A sand-bag was thrown across the rails, and the car repeatedly run at it, with the result that the bag was removed clear of the track, and the brake automatically applied every time. The instant the pressure was withdrawn from the protectors the brake came off again automatically. It certainly seems from the accounts we have received as if Mr. Porri had tackled, with a considerable show of success, a most important detail in mechanical tramways.

THE EDINBURGH EXHIBITION.—V.

At stand 62 Messrs. Ernest Scott and Co., electrical and general engineers, of the Close Works, Newcastle-on-Tyne, show a varied exhibit of electrical machinery, the plant in operation consisting, briefly, of one 9½in. by 9in. vertical high-speed engine, driving one 15-unit "Tyne" compound-wound dynamo machine; one 8¼in. by 8in. vertical engine of the same type, driving an alternating-current dynamo; one 6¼in. by 6in. vertical engine, also of the same type, but coupled direct to an 80-light "Tyne" slow-speed dynamo, the combined plant being suitable for ship lighting.

The engines are all of a special type, designed for electric light driving, and being arranged so that little or no attention is required to the lubrication, as the crankshaft runs in oil. The regulating governor for controlling the speed of the engines is of the Pickering type, working on to an equilibrium throttle-valve, and hence constant speed is maintained under varying loads.

The 15-unit Tyne compound-wound dynamo, which is illustrated by block No. 1, is of the standard type manufactured by Messrs. Ernest Scott and Co., and it will be observed that the machine is not only very substantial in construction, but so constructed that it can be taken to pieces if desired by simply removing four bolts, which allows the top half of the machine to be lifted off and the armature taken out. The armature is of the firm's special design, and so wound that not only has it good ventilation, but in case of an accidental burning out of any of the coils a new coil can be wound on without removing the armature spindle from the machine. The dynamo, although of the four-pole type, is so cross-connected that two brushes only are used.


TYNE DYNAMO Nº8.
ERNEST SCOTT & CO.
NEWCASTLE.ON.TYNE.

3307 A

18 x 11

fig 3 Dynamos & Current [illegible]
with Ernest Scott.

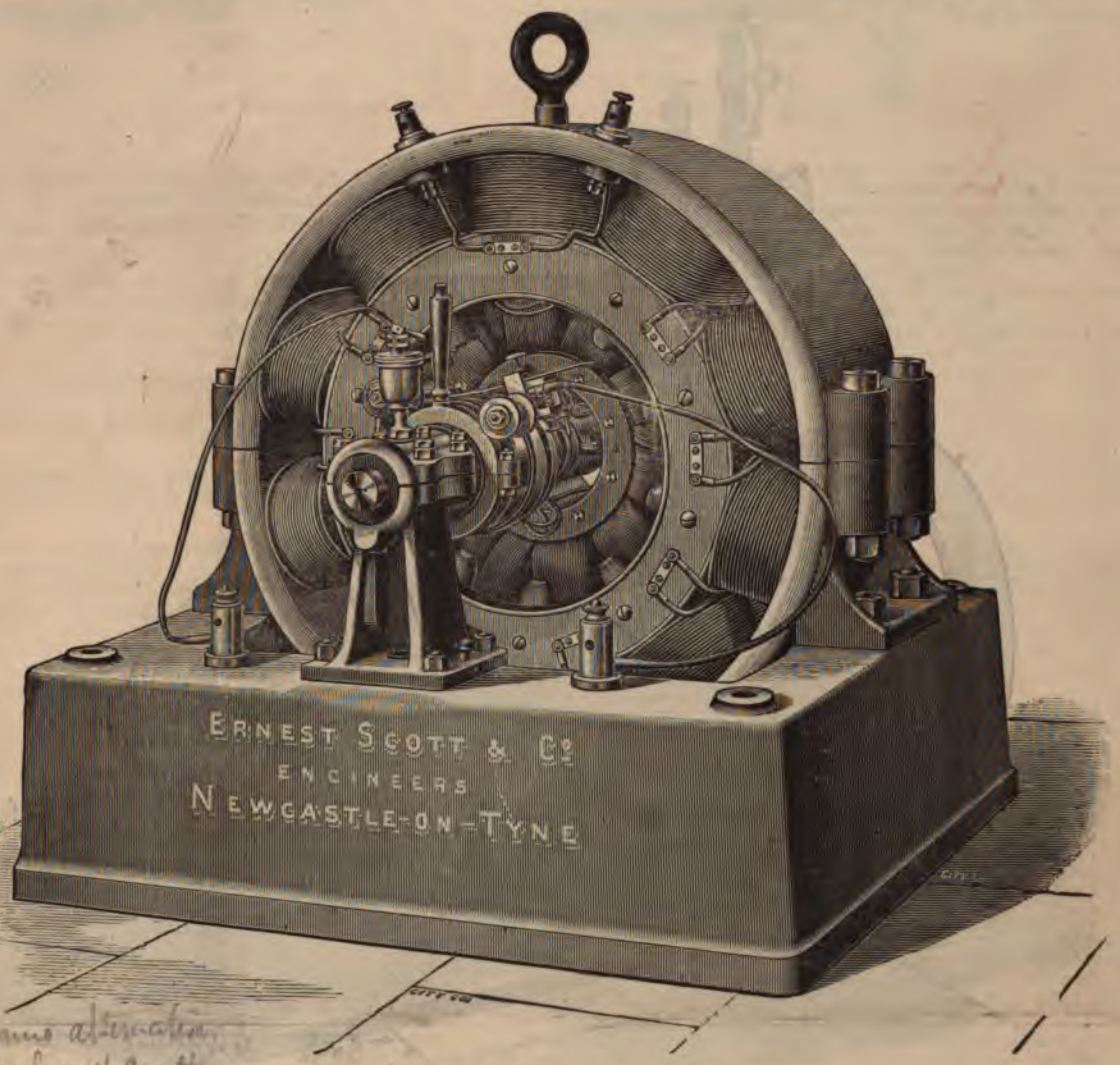
FIG. 1.

The commutator is of hard-drawn, high-conductivity copper, the sections being insulated from each other by mica. The copper segments are mounted upon a gun-metal sleeve, secured by coned ends and a lock-nut to the copper sections. This method of constructing the commutator admits of it being taken off and replaced without the segments falling to pieces, and in places where the dynamos are likely to be placed in the hands of inexperienced men, this matter is of considerable importance.

This machine is generating current for about 200 incandescent lamps of 16 c.p. each, distributed on their own stand, in the Machinery Court, and in the Locomotive Section. They supply the whole of the current for the Locomotive Section, including the lighting of the saloon carriage and engine lamps on the North-Eastern Railway Company's and North-Western Railway Company's engines, and they supply the current for working the model of the "Dreadnought" and North-Western Company's tube-cutting machine.

The "Tyne" alternating-current dynamo, which is illustrated by wood-cut No. 2, is of Messrs. Ernest Scott and Co.'s standard type, and is shown in practical work. This dynamo is designed to give an output of 1,000 volts and a current of from 10 to 15 amperes when running at a speed of 1,200 revolutions per minute. On reference to our wood-cut it will be observed that the machine in question is fitted with 10 magnets, arranged radially round the magnet frame and looking inwards. These magnets are wound with insulated copper wire, and are excited by an ordinary dynamo, which, however, can be coupled direct to the dynamo spindle if desired. The armature, the core of which is built up of rectangular iron wire, each being insulated by thin paper, is wound with 10 bobbins of insulated wire. This method of constructing the armature admits of perfect ventilation, and also enables the sections to be easily examined. The current from the armature is led by copper conductors, insulated with indiarubber, to the collector, which consists of two gunmetal rings mounted upon a hollow gunmetal sleeve. The collecting rings are insulated from the sleeve by means of ebonite rings and thin ebonite washers. The current from the collector rings is collected by two brushes supported in brush holders, the spindles of the latter being insulated from the frame of the machine by ebonite bushes and washers, thus ensuring as good an insulation as possible.

The bearings of this machine, as of all dynamos manufactured by Messrs. Ernest Scott and Co., consist of cast-iron pedestals, accurately bored and fitted with adjustable caps, the bearing being bushed with gunmetal in halves, which are lined with "Esco" anti-friction white metal. By this method the bearings can be readily adjusted, and in case of wear the bushes can be removed from the machine and run up with new metal without having to remove the pedestals themselves. The "Tyne" alternator is feeding about 150 incandescent lamps of 16 c.p. each, distributed in the Fish Dining-rooms, the Queen's Tea-room, Messrs. Cadbury's Cocoa-rooms and Smoke-room, and the Venetian Glass Works. The high-tension current (1,000 volts) is conveyed by means of copper cables consisting of seven wires of No. 20 B.W.G., and is transformed in each of these places by the "Tyne" transformer to an E.M.F. of 100 volts.



2207
10×1

fig 2 dynamo alternator
de M. Ernest Scott

FIG. 2.

The combined plant, illustrated by block No. 3, has been designed and made by Messrs. Ernest Scott and Co. for ship lighting and where space is limited, and it will be noted that the plant is very compact, and occupies but little room compared with its output.

This plant is manufactured in six standard sizes—viz., from 50 to 250 16-c.p. lamps—the speed of the smallest size being 350 revolutions per minute, and of the largest 250 revolutions. Amongst the installations in which this plant has been used we may mention the lighting of the steamships "Oxus," "Amur," and "Pallas." In addition to these, the firm have supplied one of the largest sized plants for the lighting of the Argentine Meat Company's new works in the Argentine Republic, South America, and have in hand at the present time several sets, including one for a frozen meat store at Bristol.

The "Tyne" transformer, which is shown on the stand, and which is of the same type as those used for the outside illumination, is constructed for transforming a current of high tension and small quantity to a current of low tension and large quantity. We were told that the efficiency of this type of transformer was as high as 97 per cent. They have been designed to admit of the ready removal of the primary and secondary coils by simply removing the cover. For outdoor work, and to conform to the requirements of the Board of Trade, the transformers are placed in cast-iron boxes with watertight doors, the primary and secondary fuses being mounted on porcelain bases placed inside the box. As the transformer itself is insulated from the box, it is impossible for anyone to get a shock by touching it should there be a leakage on the primary or secondary mains.

Messrs. Ernest Scott and Co. also show various types of main switchboards for high and low tension currents, Tyne arc lamps of 2,000 nominal candle-power, and a selection of electroliers suitable for private house lighting.

In addition to the dynamos which the firm show on their stand, we may mention that they have a 2-unit shunt machine working on Messrs. Priestman Bros.' stand, charging accumulators, and making a complete installation for private house lighting.

We may mention that the whole of the dynamos and electrical machinery exhibited by the firm have been designed by Mr. W. C. Mountain, a well-known electrical engineer, formerly manager of the Gulcher Company, and now a partner of this firm.

MESSRS. CROMPTON AND CO.

On Friday evening, May 30, the annual dinner of the past and present pupils and friends of this firm was held at the Café Royal. This annual festival forms one of the pleasantest *réunions* of the season, and not only is it pleasant in the social sense, but it is customary to give it an intensely practical bearing. To record the names of guests, and to describe the dinner and its surroundings is not our purpose. It will suffice to say the dinner was excellently served, and the guests were numerous. The primary object of the meeting, however, is to bring the past and present students together, to enable them to compare notes of the year's doings, and to take credit for the positions they are making in the world of electricity. According to all accounts, from the mayor downwards, the pupils at Chelmsford are usually a happy lot, with plenty of animal spirits, while a glance at what they do and the positions they take shows that beneath the animal spirits rests a desire to learn their business and climb the ladder of success. As was stated at the dinner, old pupils of Crompton and Co. are met with everywhere, undertaking serious responsibilities, the due carrying out of which reflects credit on themselves, on the firm that trained them, and on the industry at large. Many names were mentioned of those who had attained such positions, but it would be invidious to mention them, as those named only form a small part of the whole. The two texts to which we desire to direct attention were prominently brought forward during the speeches of the evening, and will no doubt form subjects of quiet consideration by all those present. Mr. Crompton was particularly happy in his reference to friends and sympathisers. He pointed out that the industry owes much to those sympathisers, who never lost their faith in the darkest days following company-mongering, or lost their heads over rash speculation in lieu of honest work. The present position of the industry is due to the unfailing and unwavering assistance of these sympathisers. The other text was that of "our competitors." Both Mr. Crompton and Mr. Garcke congratulated the meeting upon the difference in tone between competitors now and in the past. Then there existed no reciprocity. Every man's hand was marked by intense selfishness, information which would assist the common work and harm no one was withheld, but latterly another spirit has sprung up, and among the larger and better known firms common action is not unknown, fair trade rivalry is appreciated, and a firm *esprit de corps* exists. These texts are worthy the consideration of the whole profession, and not merely of those present at this dinner. The sympathy of the buying public is desirable to gain, and the prospect of work is sufficiently good to induce every firm to compete in a fair manner. Other questions were raised such as will tax the energies of the technical press for some time to come to grasp and guide to a proper conclusion. A hearty vote of thanks was given to Messrs. Crompton and Co. for their hospitality, and those present wended their ways to all quarters of the globe happier for having met, and by the thought of meeting again.

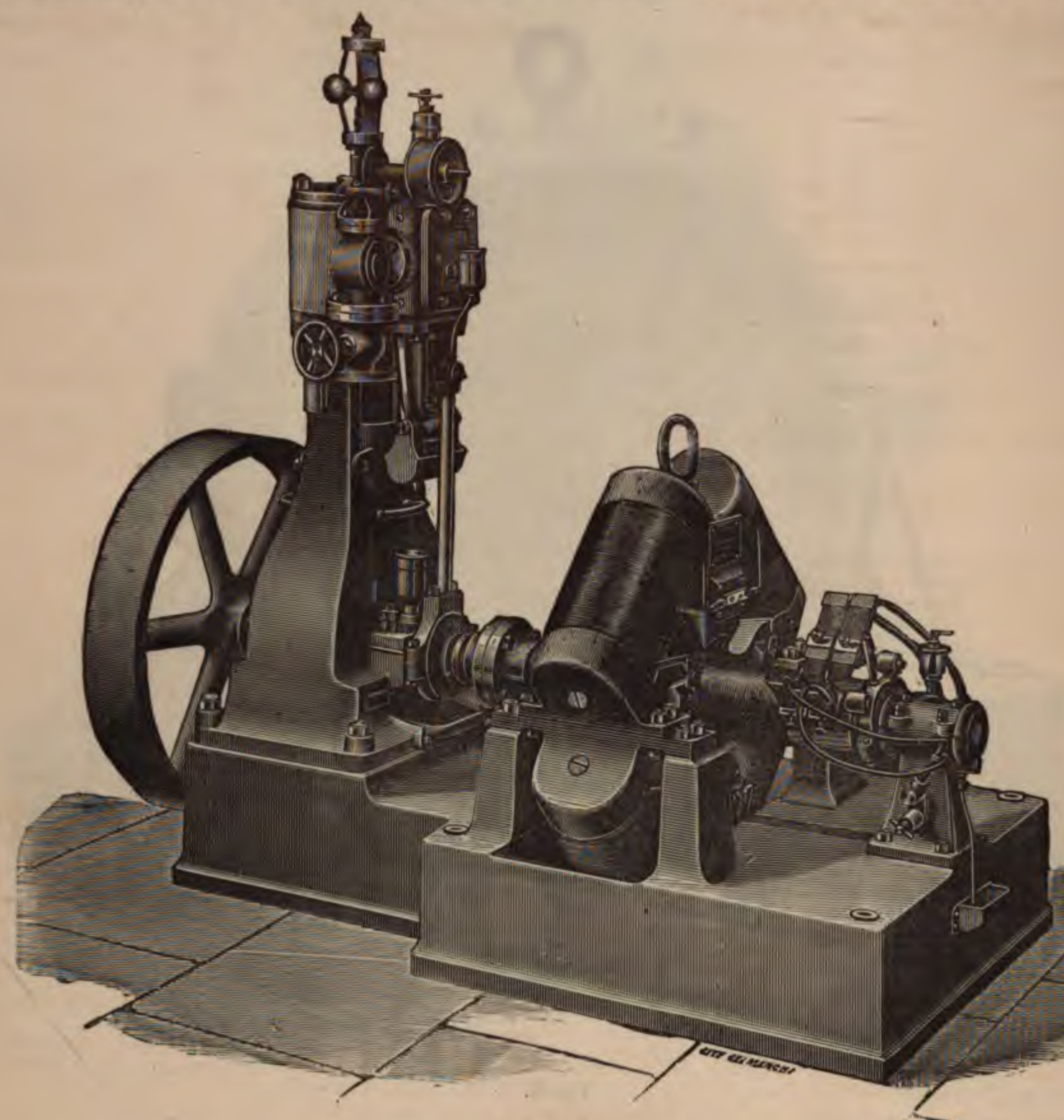


FIG. 3.

DYNAMO REGULATORS.

In the accompanying illustrations Fig. 1 represents a side elevation and Fig. 2 a plan of the Goolden and Ravenshaw dynamo regulators. The left end of the lever, C, is moved by a solenoid core which rises or descends according as the current increases or decreases, and this movement is imparted to the socket, which can be moved on to the shaft A, held by points, K. As, however, the socket is wedged upon the shaft through *a*, the shaft A must move as soon as the pin, *b*, engages in the steps of one of the two spirals E or E¹. These spirals are cut, in the contrary sense, in the revolving shafts, D and D¹, carried in the bearings, F and F¹, and the shaft A must therefore turn in the opposite direction according as B is moved in the one or the other direction.

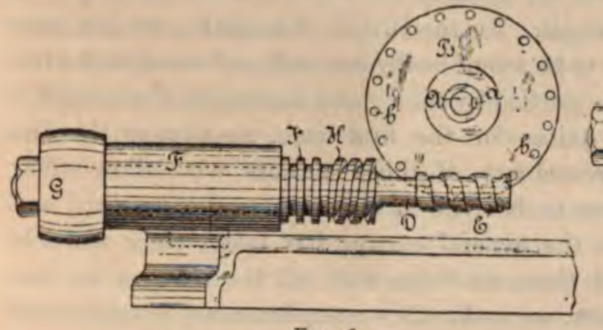


FIG. 1.

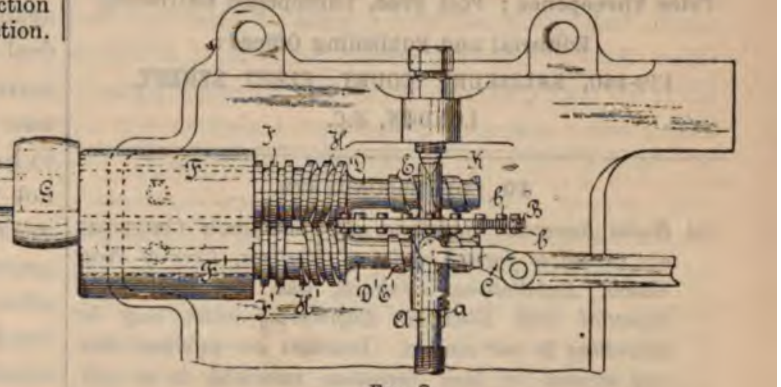


FIG. 2.

A matrix, which lies on a spiral cut in its fore part, is thereby actuated, and this inserts in or withdraws the rheostat wire from the circuit. The shaft D is driven by the motor from the bell-pulley, G. The threads, H and H¹, which engage with each other, endeavour to push in the direction of their axis, and they press against one another, the friction plates, J and J¹, being supported in this by the shaft D¹.

PADDINGTON AND THE ELECTRIC LIGHT.

SERIOUS CHARGE BY MR. FARDELL.—DECISION OF THE VESTRY.—APPEAL OF THE MINORITY TO THE BOARD OF TRADE.

At the ordinary meeting of the Paddington Vestry on May 20, a resolution was proposed withdrawing the opposition to the application of the Metropolitan Electric Supply Company for a provisional order.

Mr. Fardell said if the matter was further postponed there would be a lot of difficulty in the parish by attempts being made to influence members of the Vestry. He had absolute proof that in another matter money had been offered.

Mr. Judge (indignantly): I challenge Mr. Fardell to produce his "absolute proof" that members of this Vestry have been bribed, and I strongly protest against such an assertion without proof being given.

Mr. Fardell: I never said that members of this Vestry had been bribed. I said money had been offered to individuals for the purpose of influencing the Vestry, and I have proof.

Mr. Judge: Then indicate your "proof."

Mr. Fardell declined to give the proof.

After further discussion the division was taken, with the result that 35 voted for and 21 against, and the proposition was declared carried, Mr. Judge protesting against it.

A special meeting of the Vestry was held on Thursday, May 29, when a resolution was passed by 37 votes against 19 (three members not voting), formally consenting to the application of the Metropolitan Electric Supply Company, Limited.

The same afternoon the following opposition memorial was forwarded to the President of the Board of Trade:

PADDINGTON AND THE ELECTRIC LIGHTING ACTS, 1882 AND 1888.

MEMORIAL TO THE RIGHT HON. SIR MICHAEL HICKS-BEACH, BART., M.P., PRESIDENT OF THE BOARD OF TRADE.

The memorial of the undersigned members of the Paddington Vestry showeth:

1. That at the conclusion of the special meeting of the Vestry this day (May 29, 1890) a conference of members was held for the purpose of giving consideration to the irregular procedure of the Vestry in the matter of the resolution passed at the said special meeting, a copy of such resolution being as follows: "That pursuant to the rules of the Board of Trade the Vestry formally consents to the application of the Metropolitan Electric Supply Company, Limited, under the Electric Lighting Acts, for a provisional order for the supply of electricity in the parish, subject to the approval of the Board of Trade."

2. That the members of this conference consisted of Messrs. M. P. Beverley, J. Wallis Chapman, J. H. Dell, J. Fletcher, J. Hills, J. G. Hunt, Mark H. Judge, Uriah Maggs, Halford L. Mills, W. H. Mills, W. Murrell, Wm. Rayner, Charles See, and W. H. Stewart, and other members of the Vestry.

3 That the members of the conference deputed the undersigned to make representations to the Board of Trade with regard to the said irregular procedure of the Vestry, pointing out the chief facts connected therewith.

4. That on February 19th, 1890, the Vestry, 47 members being present, passed a resolution instructing the solicitor "to oppose all applications for provisional orders" this session.

5. The Vestry was subsequently informed that the Board of Trade would not proceed with the granting of any provisional order where the consent of the local authority had not been obtained.

6. The Kensington and Knightsbridge Electric Supply Corporation, one of the applicants for a provisional order, then requested the Board of Trade to dispense with the consent of the local authority in the case of Paddington. A copy of this consent was sent to the Vestry by the Board of Trade; and the Vestry, on March 18, in a meeting of 49 members, resolved, *nem. con.*, "That the Board of Trade be asked to adhere to its decision that no order shall be proceeded with in the case of parishes where the consent of the local authority had not been obtained before the date named in their resolution; also that such Board be informed that the Vestry solicitor has been instructed to oppose all applications for provisional orders."

7. The resolutions of Feb. 18 and March 18 have not been rescinded.

8. The rules made by the Board of Trade under the Electric Lighting Acts, and which are defined by section 5 of the Act of 1882 as being "of the same force as if enacted by this Act, and shall be judicially noticed," require (rule 16) that proof of the consent of the local authority "be completed on or before February 25."

9. There having been no demand for the electric light on the part of any section of the ratepayers, no further action was taken by the Vestry until April 22, and therefore, in the opinion of your memorialists, the time had passed when the Vestry could legally give its consent to any application for a provisional order during the present session.

10. On April 22 the Vestry, without previous notice (and without rescinding the resolution of February 18 and March 18), took the following motion into consideration: "That as the Metropolitan Electric Supply Company's terms are the most favourable, and that company works both the high and low pressure systems, and bearing in mind that it has practically accepted the provisional order as amended, as well as the condition to deposit £20,000, and, moreover, has not solicited the Board of Trade to act independently, the Vestry do discontinue its opposition in respect of that company, and that the resolution of the 18th of February, 1890, be varied accordingly." A division was taken on this motion, when 27 members were present, 14 voted for the motion, 10 against it, and three did not vote. The motion was declared to be carried, though section 57 of the Metropolis Local Management Act of 1885 provides that under the circumstances stated "no resolution or other act of any vestry shall be revoked or altered at any subsequent meeting unless such revocation or alteration shall be determined by a majority consisting of two-thirds of the members present at such subsequent meeting." The facts connected with the alleged passing of this resolution were submitted to the Board of Trade, with the result that the Vestry received a letter from the Board declining to accept the resolution, and further pointing out the necessary consent of the Vestry could only be given at a special meeting held after a month's notice.

11. A requisition was then signed by a number of members of the Vestry, asking the vestry clerk to convene a special meeting on May 29 to take into consideration the resolution quoted in the second paragraph of this memorial. The vestry clerk, therefore, issued to the members of the Vestry notices for this special meeting, under date of April 28, but public notice of the meeting, as required by the Metropolis Local Management Acts, was not given. Independent ratepayers are ready to testify as to the absence of public notice of this meeting.

12. Your memorialists trust that the Board of Trade will not entertain the granting of any provisional order for Paddington under an application which has been opposed by the local authority up to the last moment, and that the Board will not take any action dispensing with strict compliance with the Electric Lighting Acts, or to the rules forming part thereof.

13. In conclusion, your memorialists, as ratepayers and members of the local authority, hereby formally gives notice of opposition to all applications for provisional orders for Paddington this session, and in case the Board of Trade should, under any circumstances, contemplate granting any such provisional order this session, your memorialists desire to be heard in opposition to the same, and hereby request that previous to any such order being granted, a local enquiry be held as provided for by Rule 10.

Signed at the request of, and on behalf of the above-mentioned conference of members of the Vestry of Paddington.

MARK H. JUDGE, 15, Connaught-square, W.
W. H. MILLS, 19, Cambridge-terrace, Hyde Park.

Paddington, May 29, 1890.

THE

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IMPORTANT NOTICE.

We may occasionally follow the lead of our American Contemporaries, especially when they point out a serviceable way. They are not backward in asking their friends to do all they can for the welfare of the paper. We ask our friends to remember us. No paper that we know ever refuses Subscribers or Advertisers. Nor do we; in fact, we invite them, believing that they will get full value for their money.

Specimen copies of the paper will be sent on request.

THE AMENITIES OF ELECTRICAL ENGINEERS.

The season of scientific talk is over, and will not commence again until next October or November. Of course there will be the British Association in the interval, and a little scientific talk will then again be heard, but that will be mixed with a good deal of social amusement and will not be very controversial. At the British Association we are content to be scientifically amused, and we submit even to be startled by some great discoveries announced—not quite—for the first time, we admire the disinterestedness of those authors who allow their papers to be read at the end of the meeting, and after the general exodus has taken place towards lunch time, we listen with all the interest we can muster, we make a few complimentary remarks, and then the next paper is called for. There is hardly any real discussion. Now the amenities of scientific intercourse are brought forward and set, so to speak, into relief in the discussions which take place after the reading of papers. It is on these occasions that we have the best opportunity of getting information, not only on technical points, but also as regards the character, tact, and general intellectual calibre of our professional brethren.

The theatre at 25, Great George-street is an arena where many an intellectual tournament is fought during the season which we have called the season of scientific talk, and now that this is over it behoves us to enquire whether the electrical knights in these tournaments have generally acquitted themselves of their task in a chivalrous way. In the days of Mr. Pickwick scientific societies were characterised by the admiration the members had or at least expressed for each other. With this feeling the Electrical Engineers are obviously not encumbered, and their meetings are consequently far more lively than were those of the venerable societies of previous generations. The same may be said of American societies, but in Germany, France, and on the Continent generally the proceedings are dull. Not on account of mutual admiration, but simply because the rank and file dare not criticise what is said by the few prominent members or representatives of prominent firms in the profession. With us there is no such spirit. We attack right and left with perfect disregard of the professional or social standing of the persons attacked, and thus keep up a true democratic spirit. This is as it should be, for science is no cringer to those in power. That we speak our minds and combat opinions or statements which we honestly believe to be erroneous is right, but apart from this, there arises the question whether our methods of attack are in all cases the best that could be adopted. This question, we fear, will be negatived upon close examination of the proceedings during the last session of the Electrical Engineers. In too many cases the attack was not directed against opinions or theories, but against the men who put them forth. Many of the speakers in the discussions did not contribute one iota to the knowledge on the subject under discussion, but managed to show, or at any rate attempted to show, that the author or previous speaker knew nothing about the subject, whereas the present speaker knew all about it. This sort of thing may be amusing at the time, but it certainly does not conduce to the advancement of science or increase the prestige of the Institution.

The quarrel between the professor and the practical engineer is one of long standing. The former does not easily forgive the sins of the latter as to disregarding the accepted scholastic methods, nomenclature, and scientific systems. On the other hand, the practical man knows very well that he has always to show the way, and that only after he has worked out a new development in his own way the professor comes along, and with the air of a mentor shows why the thing must be done in this particular way and in no other. Thereupon the practical man waxes wroth, and, if in a discussion at the Institution occasion offers, tells the professor point blank that he knows nothing about the subject under discussion, having never in his life done the particular thing in question. Surely such an attack, to say nothing about its want of good manners, is unfair and ungrateful. It may be true enough that the professor has never put up a central station, built a large dynamo or laid an underground main, but that is no reason why we should undervalue his merit in aiding generally in the development of all these things. His work as the expounder and explainer of the why and wherefore of practical achievements is as meritorious and necessary as the latter are themselves, to say nothing of his further merit of educating the students who eventually will help the practical man in his work.

But it is not only with professors that practical men quarrel. They quarrel as much among themselves; and not content with doing so in their own Institution they must carry the war into the friendly camp of the Institution of Civil Engineers. Before that body there were recently read two electrical papers. One was on electric welding, and the other was a description of a central station worked by water power. The discussion on the former paper was unique on account of the contradictory statements put forward by successive speakers. The differences of opinion were even greater than those existing amongst the so-called sewage doctors, and the manner in which these contradictions were made was not that to which the Institution of Civil Engineers is accustomed. There is no secretary of a scientific society more anxious to secure a good discussion than Mr. Forrest, and with this object in view he invites the attendance of all those who may be supposed to know something practically of the subject before the institution. Unfortunately, in the case we have cited, very few of our practical electricians had any experience with the subject of the paper. Under such circumstances a wise man would keep his seat and hold his tongue, but the temptation to be heard by a crowded audience of the greatest engineering society in the world was too much for some of our electrical engineers, and they rushed into the controversy, advancing opinions instead of facts, and contradicting each other in the most positive manner. That the impression left upon the members of the Institution of Civil Engineers—who are old fashioned enough to regard moderation and courtesy of debate as essential to their own proceedings—was not a favourable one, might have been gathered from subsequent conversations at the Whitehall Club. In plain English the verdict of the older engineers was, "You electrical engineers do not seem to be very certain of your work, to judge by the way in which you contradict each other." We have no wish to play the part of mentor to the electrical engineering profession at large, but we would just remind the more impetuous members who sin against what is considered decorous and right by other scientific societies, that they will not benefit either themselves or conduce to the welfare of their Institution if they continue their policy of self-advertisement and personality in debate.

CORRESPONDENCE.

THE LANE FOX PATENTS.

To the Editor of The Electrical Engineer.

Sir,—1. As some misapprehension appears to exist in the mind of the public as to these patents, we wish to point out that they are at present held by the Lane Fox Electrical Company, Limited, subject to licenses granted to the Brush Electrical Engineering Company (as successors of the Anglo-American Brush Electric Light Corporation), the Edison-Swan United Company, and certain other persons abroad.

2. In the case of one patent, 3,988** of 1878, for distribution, Messrs. Crompton and Co., and the Swan United Company, have obtained an exemption from proceedings for infringement of the patents prior to December, 1882.

3. The Lane Fox Electrical Company, Limited, has been formed not merely, as has been alleged, to collect royalties, but to carry on a general electrical and incandescent lamp manufacturing business. If the company is fairly met in the question of royalties, but a small charge will be imposed; and it is anticipated that when the question is more fully understood, the reasonableness of the company's charges will be appreciated by the industry.

4. It should be borne in mind that the Lane Fox patents are in no way invalidated by the long period during which they have been, or appear to have been, in suspense; nor, on the other hand, has that suspense been the fault of Mr. Lane Fox, or designed by him with a view of entrapping companies into their use.

5. At an early period the Lane Fox patents were disposed of by Mr. Lane Fox, to be worked with other patents, to the British Electric Light Company, Limited, and subsequently to the Anglo-American Brush Electric Light Cor-

poration. Those who are conversant with the early history of electric lighting will know that until recently the principles of incandescent electric lighting were not generally understood, and though Mr. Lane Fox himself well knew the value of his patents, they were not properly appreciated by the companies who held them, and were mixed up and entangled with the claims of other patents held by the same companies for other and competent objects.

6. In illustration of the general contemporary ignorance of the principles now stated to be obvious, it may be mentioned that when first enunciated by Mr. Lane Fox they were received with ridicule and decried as impracticable, and that such staunch supporters of the system as Messrs. R. E. B. Crompton and W. H. Preece were at first opposed to them; even so great an authority as Sir William Thomson had for a time his doubts as to their theoretical soundness.

7. This opportunity may be taken to correct an impression which, to our great surprise, appears to prevail—namely, that Mr. Lane Fox confined himself, some 12 years ago, to shadowing forth the bare outlines of a scheme the essential details of which were laboriously worked out by others. This is not true. Not only were the principles of incandescent electric lighting distinctly enunciated by Mr. Lane Fox as stated above, but all details necessary to their efficient application were worked out by him independently, or through his agency, during the years 1878 to 1883. Thus in his hands the system became a thoroughly working system; installations were put up at home and abroad, and when Mr. Lane Fox temporarily abandoned electric work at the end of 1883 his system, which was ridiculed as late as 1881, was accepted and largely used.

8. After many abortive attempts to regain possession of the patents, attempts giving rise to "agreement" after "agreement" (each, as it was subsequently found, adding to rather than removing the confusion), an agreement was finally come to upon the conclusion of the recent litigation between the Anglo-American Brush Electric Light Corporation and the Edison-Swan United Company, Limited. By this agreement, dated 3rd December, 1889, each of the two litigating companies obtained a license to use the patents in the future, and an indemnity in respect of the past, but subject thereto and to certain licenses affecting the foreign patents, all the patents were assigned absolutely to Mr. Lane Fox.

9. In February of this year the Lane Fox Electric Company, Limited, was formed to carry out the long-postponed designs of Mr. Lane Fox, and to vindicate his position as the inventor of the true principles of incandescent electric lighting. The company, however, do not propose to charge vindictive royalties, or in any way to attempt to impede the progress already made, even by the unauthorised use of the Lane Fox patents.

10. Many times in the course of his prolonged negotiations with the Anglo-American Brush Electric Light Corporation Mr. Lane Fox was invited by competent financiers to join in the formation of a "ring" to control to their own exclusive advantage the electrical industry. Mr. Lane Fox declined. He wished to liberate and not to strangle the industry. Such still is his wish; and the wish of the Lane Fox Electrical Company is the same; but as true liberty consists in justice, and not in injustice, the company will vindicate the patents, and insist upon the payment of royalties in respect of them.

11. In pursuance of this purpose the company have formulated proposals, the terms of which will in due course be advertised; the pith of these proposals being that if those now using the patents will accept the proposed terms, or such modification of them as may be agreed upon by the middle of June next, no royalties will be claimed for the use of the patents prior to December 31, 1889.

12. It is confidently hoped that the companies and the electrical industry generally will see the fairness and reasonableness of the terms proposed, and will co-operate in giving Mr. Lane Fox the position he can fairly claim in the electrical world.—Yours, etc.,

C. A. STEPHENSON,
Managing Director Lane Fox Electrical Company,
May 31, 1890. Limited.

TO HAUL OUR READERS!

Whatever be the creeds of men,
Their race, or clique, or faction,
We're quite indifferent to them
And fairly gone on Traction.

The wind may blow, the rain may pour,
And down the people's backs run,
We only go and shut the door,
And hurry on with Traction.

Electric lights we patronise,
That is, we don't attack some;
On ev'ry subject we are wise,
But ain't we nuts on Traction!

On engines we're Willan to oblige,
Though fonder still of Paxman,
And wouldn't Robey of a prize
For he is great "at-traction."

Though Ransome is as Ransome does
He never fails in action,
But then we never make a fuss
When things go wrong in Traction.

If Weatherby fine then Rust-on adds
To summer shows distraction,
And Marshalls all his latest fads
With other cranks on Traction.

And so our readers may be sure
We shan't the beaten track shun,
But well or ill, or rich or poor,
Continue haul for Traction.

PROF. ELIHU THOMSON'S ELECTROMAGNETIC INDUCTION EXPERIMENTS.*

BY J. A. FLEMING, M.A., D.SC., M.I.E.E.

(Continued from page 434).

One of the most beautiful of Prof. Thomson's experiments illustrating this repulsion can, I think, be shown to you now.

An incandescent lamp is attached to the terminals of a coil of wire, and the coil and lamp floated in water or hung from a scale beam (Fig. 24) over the pole of an alternating magnet.

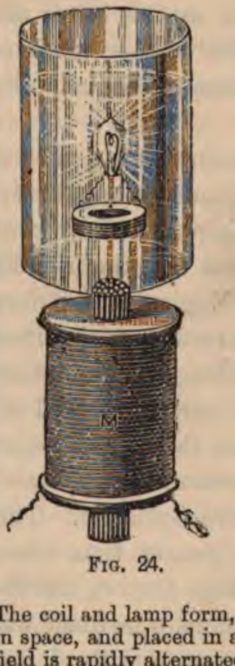

FIG. 24.

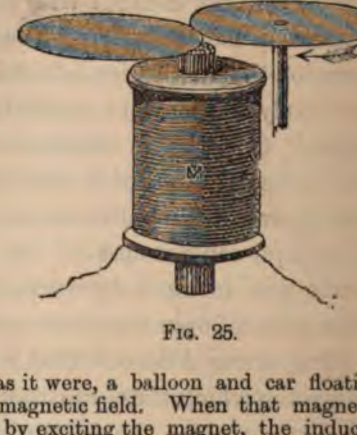

FIG. 25.

The coil and lamp form, as it were, a balloon and car floating in space, and placed in a magnetic field. When that magnetic field is rapidly alternated by exciting the magnet, the induced currents created in the coil make themselves evident by illuminating the lamp, and the repulsive electro-dynamic action shows itself by lifting the lamp and coil upwards through the water or the air.

The same experiment renders it possible to show the effect of magnetic screening very prettily. If I introduce a plate of copper between the magnet pole and the induction coil attached to the lamp, the copper "screens" the coil from the inductive action of the pole, and the light of the lamp disappears. I must next direct your attention to some curious effects which are found to exist when two conducting circuits are exposed to the magnetic flux from an alternating magnetic pole, and which depend upon the interaction of the currents induced in each respectively. Prof. Thomson embodies these facts now to be considered in four laws, which may be briefly stated as follows:

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* Paper read before the Society of Arts, May 14, 1890.

1. If two or more closed circuits are similarly affected inductively by an alternating magnetic field they will attract one another, and tend to move into parallelism.

2. Iron or steel masses placed in an alternating field give rise to shifting magnetism or lines of force moving laterally, and may, therefore, act to move closed circuits in the path of such shifting lines.

3. Closed circuits in alternating magnetic fields or fields of varying intensity give rise to shifting magnetism, or lines of force moving laterally to their own direction, and may, therefore, act to move other closed circuits in the path of such lines.

4. Iron or steel masses may, when placed in an alternating magnetic field, interact with other such masses, or with closed electric circuits, so as to produce movement of such masses or circuits relatively, or give rise to tendencies to so move, the effects depending on continual adaptations of shifting magnetism and retained magnetism relatively.

It is a simple matter to illustrate these principles; and the experiments which are designed so to do bring before us some striking peculiarities of the action of magnetic force upon closed circuits, and upon masses of conducting and magnetisable matter.

Returning, first, to the simple experiment of a copper ring repelled by an alternating pole, we find that if we add a second ring under the first, they both attract one another, and the two rings are supported and repelled as if they were one ring. It is obvious that at any instant the induced currents in both rings are in the same direction, and hence they attract one another.

Such an attractive action can be made to produce continuous rotation. We have only to place a copper ring or plate over the alternating-current coil or pole, and then bring a copper disc, free to revolve on pivots, into proper position relatively thereto. This can best be done by placing the ring or plate so as to be somewhat to one side of the pole, so as to "shade" part of it, as it were, while a part of the pivoted disc is placed under or over it, in front of the alternating pole. The disc then begins to revolve rapidly on its pivot (Fig. 25). A little consideration shows that in this case the fixed copper plate shields a portion of the pivoted plate. The currents induced in the fixed plate attract the non-symmetrically placed induced currents in the other disc, and exert a tangential action or couple upon it, tending to pull it round. The continual repetition of this action as each portion of the place becomes in turn the seat of maximum inductive action, results in a continual revolution of the plate. Two pivoted discs may be used instead of one, and it will be found that they may each "shade" a portion of the pole, and if made to overlap they will pull each other round and revolve in opposite directions when the alternating pole acts upon them.

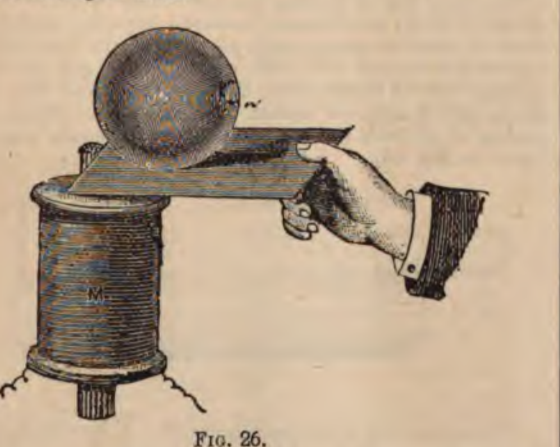

FIG. 26.

This principle of "shading" a portion of the magnetic pole, and hence causing an unsymmetrical distribution of induced currents in a conducting body capable of revolution on a pivot, has been developed by Prof. Thomson in many extraordinary ways.

Floating, for instance, a hollow sphere of copper on the surface of water in a glass vessel, he places this over an alternating magnetic pole. If the pole is placed directly under the sphere the electromagnet action would, as before explained, result in a repulsive force acting upon the disc. If, however, a sheet of copper is placed half over the pole so as to "shade" a portion of the copper sphere, the currents induced in it are unsymmetrically situated with respect to its centre, and react upon the current induced in the plate. Hence, the electromagnet action resolves itself into a torque or couple, causing the ball to spin rapidly upon its centre and take up a rapid rotation. So considerable is the rotational force brought to bear that the ball will rotate when merely laid on a sheet of copper, even overcoming the friction of such rotation on its equatorial line, provided that the ball and supporting plate are so held over an alternating pole that the plate shields a portion of the sphere (Fig. 26). Given this principle that by properly "shading" a pole from a portion of a solid body capable of revolution round a line or axis, it is easy to see that countless forms of electromotor can be designed.

A sort of anemometer, with copper discs for cups, resembling the cross of a Crookes' radiometer, can be set in rapid rotation by an alternating pole if a copper screen is placed so as to shade one side of it.

This unsymmetrical development of the induced currents can be produced by a suitable disposition of the magnetic pole alone. Thus we may place a cone or wedge of iron on the alternating pole, and hold near it a copper ring mounted so as to be able to revolve (Fig. 27). The copper cylinder or wheel revolves rapidly under the action of the periodic field, and its direction of motion is such that it seems to be blown around by a blast from the end of the magnetic cone. Prof. Thomson has constructed a curious electrical gyroscope as follows: A vertical pivot projects from the centre of an alternating pole (Fig. 28), upon which is pivoted a horizontal rod bearing a counterpoise, and a copper wheel, preferably with an iron core attached to it, gyroscope fashion, by means of a copper frame. The copper frame is placed in an inclined position with respect to the horizontal. Under these circumstances a vigorous rotation is communicated to the gyroscope wheel when the alternating field acts upon it. The copper frame shields one side of the wheel more than the other, and as a result the induced currents in the copper wheel are unsymmetrically placed with respect to its axes of rotation, and it experiences a violent torque.

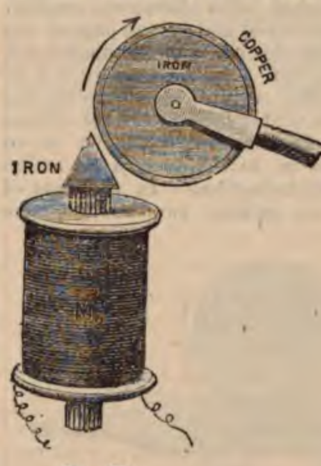

FIG. 27.

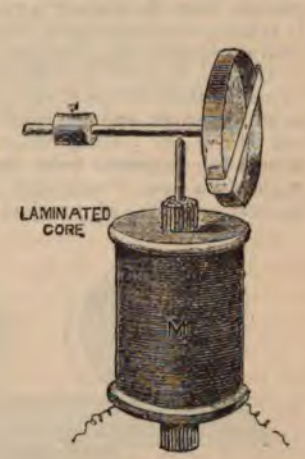

FIG. 28.

These experiments can, by a little ingenuity, be endlessly multiplied when once the fundamental principle is grasped. Bodies can be made to rotate and move, taking their movements from the magnetised space in which they are placed, and without being supplied with current from an external source.

Prof. Thomson has, however, studied some curious cases of magnetic motion, in which rotations are obtained when iron or copper pivoted discs are placed near to iron or steel bars, in which the propagation of magnetism is throttled by closed circuits. If a longitudinally laminated iron bar has a closed copper band or coil placed round it at one point, and if such a bar is made magnetic by a periodic current traversing a magnetising coil embracing another part, this structure becomes capable of rotating iron or copper discs held near it. The explanation of this effect is probably to be found in the fact that the closed embracing coil tends to throw off the magnetic lines of force laterally at that point. Consider a bar (Fig. 29), A B, in which lines of magnetic force are being established in the direction from A to B. That is to say, let magnetic induction be increasing in the bar in a direction from A to B, at C let there be a closed coil embracing the bar, the magnetic induction during its period of increase is

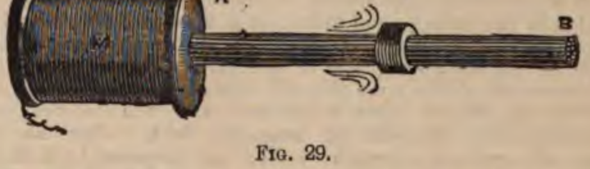

FIG. 29.

setting up in this circuit an E.M.F. which establishes in the circuit a current whose lines of force are opposed to the primary induction inside the coil, and, therefore, in the iron included in the coil, but in the same direction outside the coil, and, therefore, outside the iron. The result is as if the lines of primary magnetic induction in the iron were shed off laterally and escaped round the coil. When the magnetic induction in the iron, due to the magnetising coil, is made periodic, this action will create a kind of lateral pulsation of the magnetic lines of force in the neighbourhood of the closed coil. If, then, a movable conductor is held near such a magnetically-throttled bar, it will be subjected to a displacement of lines of magnetic force through it laterally, and will hence have eddy electric currents generated up in it. These currents, persisting into the period of reversal of the field in virtue of self-induction in the conductor, will cause the portion of the conductor in which they are set up to be continuously repelled, and hence to take up a motion of rotation. A ring of cast iron, having a closed coil wound on it at one point, is held so that another point on its circumference, 90deg. removed from the closed coil, is on the pole of an alternating magnet. An iron disc, centrally pivoted and held concentric with the ring, is rotated when the magnet is energised by an alternating current. It is not even necessary to have a closed coil on one part of the active magnetic bar, provided that this bar is not laminated, or, better still, is made of hard steel. In these cases there is a lag in magnetisation, due to either eddy currents set up in the bar or to hysteresis, and the result is a lateral escape of lines of force out of the bar. When it is held with one extremity on an alternating magnetic pole, there is in these cases an action which is a true "magnetic self-induction." In the case of electric circuits, if we join in parallel two circuits, one having very small ohmic resistance and very high self-induction, and the other very large ohmic resistance and small self-induction, a sudden flow of current chiefly selects the path of least self-induction for its flow during the variable period, although during its steady period it will chiefly flow by the path of smallest ohmic resistance; so in the case of a magnetic and conductive circuit of low magnetic and electric resistance (iron), shunted by a path of high magnetic and electric resistance (air), rapid variations of magnetic induction bring about a state of things in which the magnetic induction seems to chiefly select the path not of least but of greatest magnetic resistance during the variable period. Time will not permit me to develop at greater length the analogies of the magnetic and electric circuits under the conditions of rapidly periodic magnetic induction and electric current; but there are many suggestive ideas which arise when we place before our minds the notion of a magnetic self-induction which is the consequence of a time-element coming into action in the setting up of induction in a magnetic and conductive circuit, and due to the production of electric eddy currents, just as the electromagnetic or ordinary self-induction is the consequence of the time-element coming into action in the setting up of an electric current, and due to the production of a surrounding magnetic field. Just as the rise of current strength under an impressed E.M.F., acting in a conducting circuit, is retarded by linking that conductive circuit with a magnetic circuit, so the rise of magnetic induction under an impressed magnetising force acting on a magnetic circuit is retarded by linking that magnetic circuit with an electric conducting circuit. I am under the impression that Mr. Oliver Heaviside has developed these notions in a mathematical form, but am unable at the moment to place my hands upon the results. The effect, however, of a bar of unlaminated iron when surrounded by a magnetising coil at one end, and traversed by a periodic current, is to cause rotation in copper or iron pivoted discs held near it, or when such a bar of non-laminated iron is abutted on the pole of an alternating magnet. A bar of steel, even if not laminated, is able to cause brisk rotations in copper or iron discs under the same circumstances. With hardened steel the action is more marked. Here the hysteresis retards the propagation of the magnetic wave. By laying a large file flatwise against the alternating magnetic pole at about the middle of the file, discs of copper or iron may be kept revolving if held over those portions of the file which project from the pole of the magnet, Fig. 30. In this case the magnetic retardation in the bar is brought about by its own physical structure, and not by embracing it with a closed conducting circuit. The result is, however, the same in kind. There is a sluggishness in the establishment of the magnetic induction on the steel or iron under the action of magnetising force, which partly depends on the eddy currents in the mass of metal, and partly on hysteresis. As a consequence, we have a periodic lateral displacement of the field. The question of a magnetic leakage dependent on a retardation of induction deserves special attention in the case of commercial alternate-current transformers. Time will not permit me to enlarge on it here to any great extent, but I may observe that in the design of closed-iron circuit transformers this magnetic leakage should not be neglected.

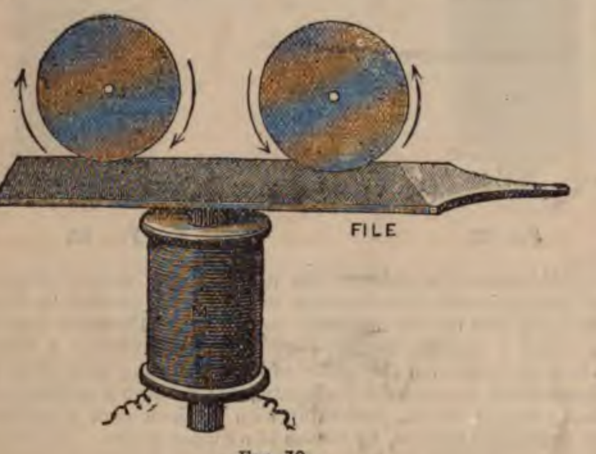

FIG. 30.

(To be concluded.)

LIGHTNING-GUARDS FOR TELEGRAPHIC PURPOSES.[*]

BY DR. OLIVER LODGE, F.R.S., MEMBER.

(Concluded from page 427.)

To suppose that the axial part of a conductor (whether solid all through or hollow, with a wire along its centre, makes no difference in principle) takes no part in conveying a momentary transfer of electricity, is to make the same error as is published so uniquely and interestingly by Sir William Thomson in the March, 1890, *Phil. Mag.*, wherein he corrects his original idea that the ordinary resistance of a ballistic galvanometer wire would not be the right resistance to introduce into its formula, because the outer layer of the wire conducts most of the current, and shows that, examining the matter still more completely, every part of the wire is ultimately effective, and equally effective as regards integral flow. All the rush does go by the outside at first, and all the *violence* is there expended anyhow, but every part of the section does its full share of conduction ultimately.

It is worth entering thus fully into the matter, because these are things about which it is easy to get bothered if one does not happen to get hold of them right way up. And this matter of protection by cages is one on which there has long been some uncertainty or hesitation.

Now that I see clearly how they act, their behaviour seems natural enough, and what one ought to have expected—what I think Maxwell (doubtless others also) would have expected; certainly it all comes out clearly enough on his principles. But a little time ago the matter was by no means so clear in my mind, and I rather gather that several others felt a similar sort of temporary uncertainty.

One more way of putting the result may be permitted. It is not given as an experiment, because I have not tried it. Take a sheet of metal or gauze, tap it along a certain line with a galvanometer on one side and with a spark gap on the other, arrange to send flashes along the same line, and then fold the sheet into a cylinder either upward or downward, so as to enclose at pleasure the galvanometer or the spark gap, but not both (*see* Fig. 24).

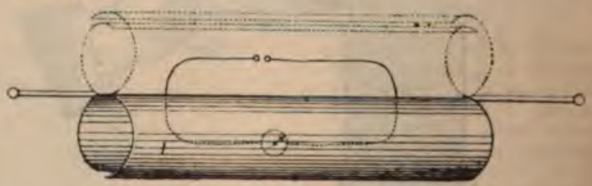

FIG. 24.

The indications of the galvanometer will be wholly unaffected by the way the sheet is folded, or whether it be left flat, provided always the insulation of its wire is and remains perfect. But to the air gap the folding of the sheet makes all the difference; when enclosed it will be quiescent, when exposed it may sparkle.

DISCUSSION.—(*Authorised Abstract*).

Mr. Saunders said he got the idea of his lightning-guard in 1864 from noticing that cables were generally connected to land lines through a fine wire enclosed in a glass tube. These wires were frequently fused, and the tubes broken, so he replaced the glass tube by a brass one connected to earth. After this fusions were less frequent. Sir W. Thomson brought out a similar device in 1872, quite independently. From the fact that in his practical experience of 25 years he had never known a cable or instrument protected by his guard to be damaged, although the wires have been often fused, he was led to believe that the arrangement was a good one. He then read a report from the Eastern Telegraph Company relating to a remarkable case of protection afforded by his guard during a very sudden and violent storm on February 14, 1888. The wire was fused, but nothing else damaged. In his opinion Dr. Lodge overestimates the chances of damage to cables, for instruments and other apparatus are more frequently injured than cables. With reference to Dr. Lodge's question as to whether unexplained faults may not be due to lightning, he said that such faults were very few. Injuries due to lightning were, he said, usually near the ends of cables, but even these were of rare occurrence. As regards Dr. Lodge's guard, Mr. Saunders thought it very ingenious, but before it could be pronounced successful it must stand the test of practical use.

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[*] "On Lightning-Guards for Telegraphic Purposes, and on the Protection of Cables from Lightning, with Observations on the Effect of Conducting Enclosures." Paper read before the Institution of Electrical Engineers, April 24th, 1890.

In reply to questions from **Sir W. Thomson**, he said he had never known condensers to be damaged. In the accident he had referred to he could not say whether the cables were in circuit with condensers or not.

Sir W. Thomson thought a condenser with Saunders's fuse wire would be an efficient protection for cables, for the quantity of electricity required to make the difference of potentials between the plates considerable would probably be more than sufficient to fuse the wire; hence the cable could never be raised to a dangerously high potential. A sufficient length of fine wire, enclosed preferably in a copper tube, would, in his opinion, prove an efficient protection for cables. He asked Mr. Saunders for the particulars of the wires generally used, and was informed that their length was 15in., diameter ·0027in., and resistance 45 ohms. These, Mr. Saunders said, frequently fused. In a lightning discharge it was probable that any free passage to earth would be taken advantage of; it was therefore important to put the fine wire beyond the spark-gap protector. He did not wish to express any adverse opinion on Dr. Lodge's guard, for he would like to see it tested in practice. At first, however, he would also insert a Saunders' protector between it and the cable as an extra precaution, for the teachings of practical experience were most valuable, and should not be neglected.

Mr. Preece said he wished to treat the question from a practical standpoint, but he was willing to admit that some attention must be paid to theory. In his opinion it was quite unnecessary to assume that lightning flashes were oscillatory in order to understand that self-induction may be beneficial in causing a discharge to jump over a spark gap, for all admit the suddenness of the flashes, and this was the only essential point. In considering the question as to whether a necessity exists for a novel lightning-protector, he pointed out that such an apparatus should either fill a want, give greater efficiency, or be more economical than the ordinary protectors. With respect to the first condition, he maintained that no want exists, for the common protectors answer all requirements. In support of this he quoted the Post Office returns for 1889, from which it appears that out of 600 valuable instruments, such as quadruplex, multiplex, Wheatstone automatics and repeaters, not a single one had suffered damage from lightning. This he considered was a strong proof of the efficiency of the methods of protection adopted. The protector consists of two circular plates separated by thin mica or by a layer of air about $\frac{1}{1000}$th of an inch thick; the self-induction of the instruments was sufficient to cause the spark to leap across the space. As to cables, he said that all the 117 under his charge were protected by the plate guards above described, but in addition a coil and fuse wire were inserted between the plates and the cable, as shown in the sketch (Fig. 25). This method had been in use since 1879 with perfect success. During the interval only one case of damage had occurred, and in this considerable doubt existed as to whether the injury was caused by lightning or not. From these facts he concluded that no want for a new protector exists, and that none can give greater efficiency. As regards economy, he said that the ordinary protectors cost from 2s. 9d. to 3s. 6d., whilst those for cables were about £1. If anything could be gained by the use of Dr. Lodge's apparatus, he (Mr. Preece) would be glad to try it, but he would also use in addition one of the ordinary protectors, which practical experience had shown to be successful.

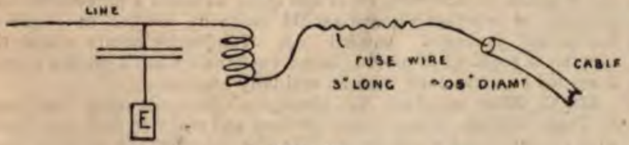

FIG. 25.

Mr. Charles Bright commented on the remarkable similarity in lightning-guards, and said their pedigrees were very interesting. The devices of the earlier workers in the field—Steinheil, Brequet, Faraday, and Walker—had been considerably improved by Varley, Siemens, Saunders and Jamieson. Steinheil, he thought, was the first to recognise the fact that the law of divided circuits was not true for rapid discharges. In Dr. Lodge's guard several new principles were involved, the chief of which seemed to be the introduction of self-induction by means of coils. The protection from damage due to electricity surging up from the earth seemed to him an important feature, in which Dr. Lodge's apparatus differed from that of Mr. Saunders. Mr. Bright then directed attention to Sir Charles Bright's guard (Fig. 26), and said it was particularly useful in cable huts, for if one wire was fused the remaining ones were available. He agreed with Dr. Lodge as to the uncertainty which must surround unexplained faults in cables, and thought that the best protection obtainable should be employed. Prof. Jamieson's guard seemed very effective.

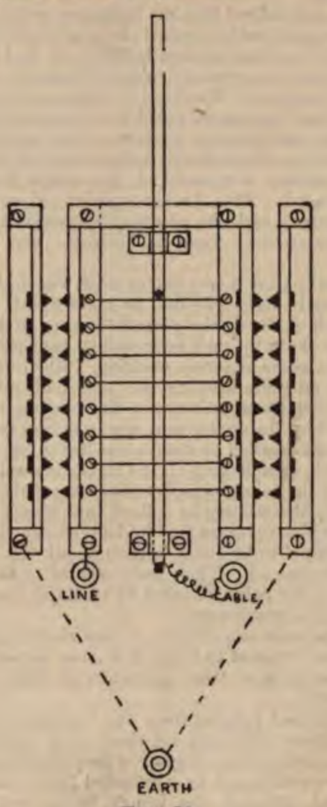

FIG. 26.

Captain Stiffe said that on the Persian Gulf cable he had used a protector consisting of a Siemens plate guard and a fine platinum wire. Sometimes the wire was melted, and the plates had been fused together, but no damage had resulted to the instruments or cable. Before the fine wire was introduced it was not uncommon to have the land-line instruments damaged.

Sir Henry Mance corroborated Captain Stiffe's statements, and said that since the Persian Gulf cable came under his charge he had modified the guard by winding the fine wire into a spiral, and enclosing it in a glass tube to prevent mechanical injury. This, he thought, somewhat resembled Dr. Lodge's arrangement of an air gap followed by a coil having self-induction. He admitted that obscure faults do sometimes occur, but did not think they were due to lightning. Siemens plate guards were fairly efficient, for the plates were rarely fused together. More frequently their surfaces were merely pitted by the discharge. In conclusion, he asked Dr. Lodge whether the spiral connections from the instruments to the cable and the coiled ends of the cable would tend to protect by virtue of their self-induction.

Major Cardew thought Dr. Lodge's apparatus was not necessary for ordinary lines. Speaking of the experiments shown at the previous meeting, he pointed out that the unprotected terminals were always struck, whereas in practice it was possible that the protected terminals might receive the discharge. If, as Dr. Lodge supposed, the line was struck outside the station, then even at a comparatively short distance away the impedance of the line would exceed that of Dr. Lodge's coils, and a kind of spark gap exists at each insulator. The successive spans and insulators would thus act as the coils and spark gaps in Dr. Lodge's apparatus.

Prof. Hughes considered the communication under discussion very important, inasmuch as it recognised the value of impedance in lightning protectors. Many of the older protectors contained analogous arrangements, but their inventors failed to see their importance. Brequet's protector, for example, consists of fine insulated iron wire wound on a brass tube and surrounded by another tube, both tubes being earthed. Each convolution of wire possesses self-induction, and the insulation acts as a spark gap, so that in effect the protector consists of a very large number of spark gaps in parallel and impedance coils in series. Referring to the cause of the galvanometer kicks about which Dr. Lodge had quoted his opinion, he said that the effect was due to a complicated series of actions, and although he agreed with Dr. Lodge's notions on the subject he still thought the main cause thermoelectric.

General Webber said one of the advantages of such papers as the one before them was that they called forth such valuable records of practical experience as those presented by Mr. Preece and Mr. Saunders. No one, excepting Major Cardew, had referred to the fact that in ordinary telegraph lines points of release occur at every insulator; from his own observations on storms in Eastern countries he was inclined to think that more protection was due to this cause than to any other. As regards electric light circuits, he enquired whether bare or covered underground conductors were most likely to be damaged by lightning. Overhead wires, he imagined, were much more likely to be injured than underground ones. Some time ago in his own house, which was then lighted by 25-volt lamps, he noticed, or thought he noticed, the lamps go dark immediately after a vivid lightning flash and again regain incandescence. The effect he attributed to some action of the flash, for an arc lamp in the vicinity was destroyed by the same discharge.

Prof. Ayrton pointed out that the lightning-protectors of Mr. Preece and Mr. Saunders could not be applied to electric light circuits, for it was admitted that plate protectors were insufficient, and the fine wire, an essential part of the arrangements, was inadmissible on account of the strong currents employed. Speaking of damage to telegraphic apparatus, he said he had known polarised relays to be frequently reversed by lightning. In one instance he saw a flash strike a line about a quarter of a mile from the station ; every insulator between the point struck and the station was smashed, the relays fused, and all the instruments damaged. This, in his opinion, showed that the self-induction of the spans and the points of release at the posts, referred to by Major Cardew and General Webber, were quite useless as protectors.

Mr. Mordey said that it was not so much the lightning that is to be feared in electric light circuits as the current from the dynamo following the path of the discharge and forming an arc. Means must be devised for breaking up such arcs, and it was more in this direction that electric light engineers were working. Electromagnetic cut-outs actuated by the currents forming the arcs had been tried for this purpose Prof. Elihu Thomson's device for blowing out the arc by a magnet energised by the arc current was in actual use in America.

Mr. Spagnoletti recalled an instance of lightning striking an aerial line and completely demolishing all the insulators and arms on 10 poles, as well as splitting the poles themselves into fragments. In another case a man was killed at Shrewsbury by a flash that struck the line 50 miles away, and on the Metropolitan line he had known an instrument in the centre of a tunnel to be fused, although all the wires connected with it were underground. These cases seemed to show that the protection afforded at the poles, referred to by Major Cardew and General Webber, to be quite insufficient.

Mr. Crompton made enquiries as to how electric light circuits were to be protected, and wished to know if it was necessary to put protectors in each house, or whether protectors at both ends of the leads would be sufficient.

Dr. Lodge said that judging from the statements of several of the speakers the ordinary protectors did their work well, but they were all open to the objection that they were frequently damaged. Whenever protectors were damaged he contended that something else had also been damaged, although the injury might not be visible. He could hardly accept the statements made by the men of experience, who said that they never came across faults that could not be accounted for, and he maintained that any unexplained fault may be due to lightning. Even a fraction of 3,000 volts, corresponding to one millimetric spark, might seriously injure a cable. As regards the advantages of fine wire, he said its use was essential to safety. In his paper he had pointed out that two things had to be guarded against—viz., high potentials and strong currents. His apparatus reduced the high potentials, and fine wire was a protection against strong currents. As pointed out by Sir W. Thomson, the fine wire should be at the protected terminals. In reply to Mr. Preece's statement that the self-induction of instruments was sufficient to cause the spark to jump across air spaces, he said that if the coils were wound on iron cores or metal reels the self-induction for flashes was negligible, and in any case lightning would take no notice of silk or cotton insulation. Moreover, the shapes of the coils used were by no means such as would give maximum self-induction. He thought Sir W. Thomson's suggestion of a fine wire and a condenser a valuable one. Referring to Brequet's protector mentioned by Prof. Hughes, he pointed out that the self-induction of the silk-covered wire was non-existent for lightning flashes. Self-induction as such was not the essence of his own apparatus, for an efficient protector requires successive spark gaps with self-induction between them. In reply to Major Cardew, he said that in his experiments he had imitated the circumstances most likely to occur. As to the relative danger to underground and overhead wires, he pointed out that the former were not entirely underground : if they were they would be more secure. Covered underground conductors would be more likely to be injured than bare ones, for the insulation of the former might be punctured, whilst the latter could only be damaged by fusion, and this was not likely to occur. He suggested that the lamp phenomenon observed by General Webber might be due to a momentary short-circuiting of the leads by induction from the lightning flash, for he himself once had his storage-battery leads short-circuited by resonance sparks caused by discharges in his experiments on lightning conductors. In answer to Mr. Crompton's enquiries, Dr. Lodge thought the same principle as is used in protecting buildings from fire by means of fireproof doors should be adopted, and protectors should be placed wherever underground wires leave the earth.

THE TREATMENT, REGULATION, AND CONTROL OF ELECTRIC SUPPLY BY THE LEGISLATURE AND THE BOARD OF TRADE.*

BY MAJOR P. CARDEW, R.E., MEMBER.

(*Concluded from page 436.*)

The rules and charges have not yet been drawn up, but it is probable that instruments will be required to be marked with a clear and intelligible scale—whether of degrees, or volts, or amperes, etc., is quite immaterial ; the extreme range of the instrument must be given approximately, and whether it is intended for alternating or continous currents or pressure, or for both. The reading given by the instrument on its own scale for each current or pressure asked for will be taken, probably, in all cases both with increasing and with decreasing readings.

No extreme accuracy will be guaranteed for these readings, but it is hoped not to exceed an error of ¼ per cent. from the true value. Of course, in the case of ordinary commercial instruments, we should give no sort of guarantee that the instrument will remain constant for any time, or under different conditions.

Sub-standards will be subjected to long and rigorous testing, including the determination of their variation under different temperature and the permanence of their constants. I am afraid, however, that in most cases there will be some difficulty in giving any guarantee of the constancy of an instrument after it has passed out of our hands.

The power for laboratory purposes will be supplied from two batteries of accumulators—one of four very large cells simply to give steady continuous currents up to 2,000 amperes ; the other, consisting at first of 100 smaller cells, will be used directly for continuous pressures up to 200 volts, and also to run the machinery. The machinery referred to is two pairs of dynamos, one of each pair being energised by the cells as a motor and driving the one connected to it as a generator. One of these generators will be an alternate-current machine, and the other a high-pressure continuous-current machine. In connection with the alternate-current machine we shall have a set of transformers. In this way we hope to get currents practically as steady as if taken direct from the accumulators, and in the case of alternating currents and pressures any frequency within the limits of practice. The limits we propose to work up to at first are—

Continuous current	2,000 amperes ;
,, pressure	2,000 volts ;
Alternating current	500 amperes ;
,, pressure	2,000 volts.

The building and alterations necessitated are now nearing completion, and we hope to have the laboratory in working order in about two months' time.

DISCUSSION.—(*Authorised Abstract.*)

Mr. Crompton expressed his opinion that the electric lighting industries had suffered considerably from over legislation, and he disagreed *in toto* with Major Cardew's statement that the Act of 1882 did not do the amount of harm generally attributed to it. He admitted that over speculation in electric light patents had a depressing effect, but he himself could vouch for the fact that the Act of 1882 prevented a large central station, in which he was interested, from being carried out. Had this been proceeded with, experience for which we had now go to America would have been gained first hand. Unnecessary legislation had also caused immature and incomplete schemes to be brought forward, and seriously interfered with the natural development of the industry. The question of sites for stations had been placed in an unsatisfactory condition, for under present circumstances it was necessary to keep their position secret, and this necessity caused hurried designs and workmanship, as well as increased cost. He firmly believed that the old method of obtaining private Bills, as for gas works, would have been far more satisfactory to all than the present system of provisional orders, and he felt quite sure that the gas works clauses could have been easily modified to make them applicable to electric lighting stations. Whilst fully admitting that the Board of Trade had done all in its power to make the Acts workable, and that the thanks of all interested were due to the officials for the great efforts they had made, he could not help thinking that the tendency of modern legislation was to interfere too much, and to show people how to do their own work. The case quoted by Major Cardew as to consumers being entitled to the choice of two pressures, one about half the other, was, in his opinion, one of undue interference, for it was quite as much a pure commercial question as whether a grocer should make up his tea in pound or half-pound packages. Another case of injustice occurs where the supplier is required to provide larger terminals when a greater supply is needed by a consumer than he orginally estimated.

Mr. G. Offer endorsed Mr. Crompton's remarks about the Board of Trade officials being always anxious and ready to deal practically with the questions which arose. He also thought that we suffer from over legislation. One serious defect of the present system was the inordinate length of time required to obtain a provisional order, for the preliminary order must be applied for in July, whilst the confirmation of the order cannot be granted until August in the following year. Should an unexpected dissolution of Parliament occur in the interval, the consequences would be very serious to the applicants. He submitted that a great improvement might be effected by materially shortening the time between the application for, and confirmation of, provisional orders, or better still by avoiding the necessity of obtaining confirmation Bills. As this confirmation is not required for licenses, he thought orders might be treated similarly. As to the position of local authorities being more favourable than that of private companies under the Acts, he thought this a distinct advantage, for it would facilitate procuration of capital for carrying out lighting schemes, whilst private companies would obtain the work without incurring all the risk. The appointment of electrical inspectors and consulting engineers were points on which he believed local authorities were somewhat confused ; and to show the state of some minds on the subject he cited a case in which a local authority wished to appoint an inspector, but stipulated that his salary was to be paid by the undertakers.

Mr. J. Shoolbred thanked Major Cardew for the concise account of provisional orders which he had given to the Institution. There were two points to which he desired to direct attention in connection with such orders—viz., the necessity for by-laws, and the question of overhead wires. By-laws, he said, were becoming more and more important for the protection of undertakers rather than for customers;

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* Paper read before the Institution of Electrical Engineers.

this he was glad to see had been partly recognised by the Board of Trade in granting access to consumers' premises in some cases, but facilities for examination of fittings, etc., were still required, for vexatious customers can and do throw serious difficulties in the way of undertakers. As regards overhead wires, he pointed out that considerable complication had been introduced by the Board of Trade legalising them to some extent, for it would lead to unfair competition. Many overhead wires had been erected without statutory powers, and if these were permitted to remain, the companies or persons in possession, although they did an illegal act in erecting them, would be allowed a great advantage over another lew-abiding company in the same district, which was compelled to put its wires underground. Referring to meters, he asked if any had been certified, and whether steps had been taken towards the formation of branch offices at which meter tests could be carried out. In the event of such offices being established he wished to know if they would be representative of the central office. Speaking of the clauses in the new model provisional order relating to the pressure being declared at the customers' terminals, he pointed out that, in some cases, a consumer may declare a pressure which it would be practically impossible for the undertakers to supply.

The discussion was then adjourned to the 22nd May.

On the 22nd ult., **Mr. A. A. Curtis Hayward** (continuing the discussion) remarked that Major Cardew's paper touched lightly on the appointment of electrical inspectors. He considered the vesting of such appointments for the metropolitan district in the London County Council a regretable incident, and was glad to note that in future orders the right of appointment would be vested in the Board of Trade. The appointments were, he said, at present very important, for the public had been somewhat alarmed by the sensational accounts of accidents in America. The knowledge that properly qualified inspectors were to be appointed would tend to restore confidence and give great satisfaction to the community. His opinion as to the future importance of electric inspectors did not coincide with that of Major Cardew, for he believed theirs would be a case of degeneration rather than one of development. He could not agree with Mr. Crompton about over legislation, and thought the latter gentleman overstated the case when he said that the gas works clauses might have been easily modified to cover electric supply. A real need for a special Act existed, for there were many subjects in electric supply, such as overhead wires, etc., which were quite foreign to gas distribution.

Mr. Emile Garcke said he was not prepared to discuss the details of the regulations in the face of Major Cardew's statement that criticism from even a high electrical authority might be erroneous. He would rather confine himself to the historical facts. The parliamentary history of electric lighting was unique, and the rapid changes that had taken place in the industry were phenomenal. The first select committee (he said) was appointed in 1879, when the commercial possibility of incandescent lighting was unknown. Its fair report encouraged contracting firms to promote Bills in Parliament. In the spring of 1882 another select committee was appointed, and in the same year the memorable Act of 1882 passed. Although its results were lamentable in one respect, he thought it not an unmitigated evil. After detailing the various attempts to remedy the defects of that legislation resulting in the Act of 1888, he pointed out that no time had been lost and that progress had been comparatively rapid. He laid great stress on the exceptional character of the legislation, even of the amended Act, saying that no other industry had ever been placed under such adverse conditions, excepting, perhaps, by the Tramways Acts, but even this was much more favourable to the contractors than the Electric Lighting Act of 1888. The exceptional character arose from the fact that Parliament refused to put electric lighting corporations on anything like the same footing as gas companies, and thus the former had to compete on very unfavourable terms. It was in the power of the gas companies, by foregoing their dividends for a year or two, to completely crush electric companies, for, in addition to their power to pay accumulative dividends, they had the advantage of practically perpetual tenure, whilst the electric companies were limited to 42 years. As regards local authorities he complained that according to present regulations it was in their power to stifle electric lighting, and as many of them were largely interested in gas, he argued that it was not right that the electric companies should be placed in such a difficult position. To show how vexatious local authorities may be, he quoted a case of a central station established in the early days of electric lighting. The work was carried out satisfactorily by overhead wires until such time as regulations were issued by the Board of Trade, stating that all wires must be put underground. In the face of the 21 years' purchase clause it was financially impossible to comply with the regulations. When the amended Act was passed in 1888, the company applied for a provisional order, but were opposed by the local authority, which was at that time negotiating for the purchase of gas works. He was not aware that any other kind of vested interests had been similarly treated.

Mr. K. L. Murray expressed the great pleasure he experienced in hearing the discussion on such an important subject, and at being in the presence of so many eminent persons on whose sayings and doings they in Australia were so largely dependent. In Victoria, he said, they had no Acts of Parliament or regulations to control electric supply, and until recently they had no rules. Last year, however, the Victoria Institute of Engineers had drawn up a set of rules based largely on those issued by this Institution and by the insurance companies. He did not agree with those who said that electric supply needed no regulation, for defective workmanship should be carefully guarded against, and for this object rules or regulations were necessary. An Act of Parliament, he said, was now expected in Victoria, and the present discussion would aid in framing the Bill. A knowledge of what to avoid as well as what to do may, he hoped, lead to a model Act, etc., from which, perhaps, the mother country might copy with advantage.

Captain Rowan said that in Australasia, where he had been engaged in introducing electric lighting, difficulties arose from want of legislation. No public body had power to give authority to lay mains or to erect overhead wires, etc., and in consequence matters had come to a deadlock. Mr. Murray, he said, had told them that legislation had been delayed until it was known what is to be done here. He hoped that the present discussion would materially assist those on the opposite side of the globe to hit the happy mean whereby public safety might be assured without the industry being hampered.

Mr. H. Human disagreed with what Mr. Crompton said about the injustice of compulsory supply at either of two pressures, and pointed out that a grocer who made up his tea or sugar in pound or half-pound packages had not a monopoly granted to him for 42 years. In his opinion there was no particular hardship to the undertakers in the regulation, whilst it was a distinct boon to customers. He thought Mr. Crompton, in his remarks about the gas and water companies, had overlooked the fact that they had been sources of complaints for years. His comparison of electricity with gas and water was not legitimate, for in the former case, where such a subtle agent as electricity was dealt with, consumers were much more at the mercy of undertakers. In America, he said, where the industry had not been hampered by legislation, there had been so many accidents and fires that the public were now appealing for control, and the wish had been expressed that a body analogous to our Board of Trade was in existence there. Speaking of safety devices, he wished to see their use made compulsory where the pressure exceeded 1,000 volts. In conclusion, he said that the Acts of Parliament, if harsh, were necessary, and he hoped that those who advised the Board of Trade would hold the scales equally between consumer and undertaker.

Mr. A. Siemens said it should be borne in mind that the objects of the legislation were twofold: (1) To empower electric supply companies, etc., to lay mains in the public streets, and conduct the business of supply in a manner recognised by law; (2) to recover charges for supply made to consumers. Both these aims were intended to confer powers on companies which otherwise they could not possess. Originally, he said, the Board of Trade had power to grant provisional orders without the consent of the local authority, but in the later development neither licenses nor orders can be granted without such consent being first obtained. In contradistinction to the case quoted by Mr. Garcke, he said that in one town a company had started a station in spite of the fact that the local authority had obtained a provisional order; subsequently the company wanted to claim compensation for loss of vested interests. There was only one point in Major Cardew's paper which he considered disputable, and that referred to testing stations at pillar boxes. In his opinion they were unnecessary, for a recording instrument in the central station should fulfil all requirements. If, however, the local authority wanted a separate station that could be easily arranged.

Mr. J. S. Fairfax hoped that no hard and fast line would be laid down as regards the kind of instrument to be used at testing stations. In his opinion the paragraph in Major Cardew's paper referred to some kind of dial arrangement, but he thought one on the deposition principle may be more correct.

Mr. E. L. de Segunds did not agree with Mr. Crompton about the Board of Trade having gone too far; in fact, he thought it had not gone far enough as regards protection of the public by making regulations for insulation tests. He knew a case where a 1,000-volt circuit was tested at 100 volts, and he pointed out that to test a steam boiler intended to work at 100lb., with water pressure at 10lb., would be considered ridiculous. The testing of house wires was also very important, for in one case he was assured that there was no defect in the insulation, for in the contractor's tests no indication of a leak was obtained. On applying Evershed's ohmmeter with about 100 volts a dead earth was indicated.

Mr. Mordey, in referring to the question of safety devices, said it was time the subject was settled. The method of earthing the secondary was, in his opinion, perfectly safe. Great opposition had been made, particularly by the insurance companies, to its adoption, but the reasons for such objections were not forthcoming. As far as he could see there was no danger whatever with the secondary volts at 100, for by earthing the middle of the secondary the greatest difference of potential possible was 50 volts. Besides, the method had also the advantage of weeding out all rotten installations. They had used the method on the Continent and found it quite successful. The fuses, however, often go, owing to persons inserting penknives, etc., into the switches for the object of obtaining agreeable medical shocks. As regards the Cardew device he pointed out that its cost was not an unimportant item; moreover, it was automatic and might not go off, and generally the fewer automatic arrangements there are about an installation the safer it is.

Mr. A. P. Trotter enquired what excess of current was required to let the fuses off, to which **Mr. Mordey** replied that about 20 per cent. above the normal was the ordinary average; in his opinion such currents could not give rise to fires.

Dr. Fleming asked what occurs in the case of an earthed secondary when the primary is also earthed. In Italy, where they had had considerable experience in alternate current distribution, the tendency was in the opposite direction, for the greatest care was taken to perfectly insulate both primary and secondary circuits. He himself had used an earthed secondary at the Inventions Exhibition and had found no difficulty, but he wished to ask Mr. Mordey what his experience was.

Mr. Mordey said that no difficulties had been met with.

Major Cardew, in reply, pointed out that the Board of Trade could not adjust or redress any wrongs, for such changes in the law must be made by Parliament. With respect to the declaration of pressure at consumers' terminals, he said this was rendered necessary by the introduction of transformers, for it was more difficult in such cases to know the fall of pressure in the distributing mains than in continuous current distribution. He then read the following draft, which is to be inserted in the new model orders: "Before commencing to give a supply of energy to any consumer the undertakers shall declare to such consumer the constant pressure at which they propose to supply energy at his terminals. The pressure so declared at any pair of consumer's terminals shall not, except by agreement, be greater than 115 volts or less than 45 volts if continuous, or the equivalents thereof respectively if alternating, and shall not at any time be altered or departed from except in consequence of any authorised alteration of the corresponding standard pressure. In distribution on the three-wire system, the central terminal shall for the purposes of this regulation be considered to form a pair with either of the outer terminals, and similarly for multiple-wire systems; and, in the case of a transformation of energy on the consumer's premises, the undertakers shall give the consumer the choice of a supply at either of two pressures, one of which shall be approximately half the other, and in such cases the pressure so chosen by the consumer shall be declared constant pressure." In drafting this clause, he said, advantage had been taken of the flexibilty of the transformer system, in the interests of consumers. Mr. Shoolbred's questions with regard to meters were answered in the paper itself, for he would there see that they were to be certified by a local inspector, and be of a pattern approved by the Board of Trade. Mr. Murray's remarks about contacts between telephone and electric light wires needed careful consideration, for this was one of the chief sources of trouble and danger where high pressures are used. To Mr. Human he pointed out that the issue of a provisional order conferred no monopoly whatever. In reply to Mr. Siemens, he could not say why the change respecting the consent of local authorities had been made by Parliament. Such, however, was the case, and the Board of Trade could not dispense with that consent except in very special cases. As regards testing stations, he thought the arrangement he had suggested would be more satisfactory to the general public than the use of pilot wires and instruments fitted in central stations. To Mr. Fairfax he explained that the reference to dial instruments in pillar boxes was intended for indicating and not for recording instruments. Speaking of safety devices, Major Cardew said the plan of earthing the secondary got rid of some defect when the earth connection was substantial, but he thought the fire risks were increased by such a procedure. He had heard of fires being caused through a small leakage current having gradually charred wood, and ultimately set it alight. The apparatus bearing his name was, he said, admittedly automatic, but its action depended only on gravity and electrostatic attraction, and neither of these were likely to alter.

PHYSICAL SOCIETY.—May 16.

Prof. W. E. AYRTON, F.R.S., President, in the chair.

Prof. W. Coleman was elected a member of the society.

Lord Rayleigh exhibited and described an arrangement of **"Huyghen's Gearing in Illustration of Electric Induction."** This gearing consists of two loose pulleys mounted on the same axle, with an endless cord laid over them, the loops or bights of which carry weighted pulleys, whose planes are parallel to the axis on which the upper pulleys turn. If one of the latter pulleys be started to rotate the other, one turns in the opposite direction until such time as the speed of rotation of the first one becomes constant. Whilst this constant speed is maintained, the second pulley remains stationary—one weight being raised and the other lowered—but on retarding the motion of the first pulley, the second commences to turn in the same direction as the first. It will be noticed that the phenomena are analogous to those which occur in electric induction, where starting or increasing a current in one circuit induces an opposite current in a neighbouring circuit, whilst decreasing or stopping a current induces one in its own direction. Lord Rayleigh pointed out that in this apparatus there is nothing strictly analogous to electric resistance, for the friction does not follow the same law. The analogy, he said, was complete as regards there being no change of potential energy, and the mathematical equations for the kinetic energy of the system are precisely the same as those given by Maxwell for electric induction.

Dr. S. P. Thompson made a communication on **"Dr. Kœnig's Researches on the Physical Basis of Music,"** in the course of which Dr. Kœnig performed numerous novel and interesting experiments, clearly illustrating the subject to a crowded audience.

COMPANIES' MEETINGS.

WESTERN COUNTIES AND SOUTH WALES TELEPHONE COMPANY.

The fifth annual ordinary general meeting of the shareholders in the Western Counties and South Wales Telephone Company, Limited, was held on the 30th ult., at the Grand Hotel, Bristol, under the presidency of Mr. Charles Nash. The report of the Directors was taken as read.

The **Chairman**, in moving the adoption of the report, expressed regret at the absence of Messrs. J. S. Forbes and J. W. Batten (nominees of the National Company), in consequence of other engagements. The time at which the meeting was held was later than usual. A principal cause of this was the influenza, and as the staff was limited in number, the disabling of three or four at the same time necessarily delayed the accounts. It would be seen that the capital expenditure to the end of 1889 was £139,993. 16s. 8d., and the gross revenue to the same date was £39,046. 19s. 6d. The whole of the preliminary expenses had now been cleared off, and not only had the plant been fully maintained and renewed, but it had in many cases been improved at considerable expense by the substitution of the more efficient and durable copper and bronze wire for iron. The Directors felt some disappointment that the result of the year's work did not enable them to recommend a dividend on the ordinary shares; it was, however, proposed to add £500 to the special reserve fund, increasing it to £1,700. One principal cause of the small amount of net revenue was mentioned in the report—viz., the heavy necessary expenditure on trunk lines. The total expenditure on trunks up to the end of 1889 was in round figures £38,000, and this large outlay was only now beginning to be remunerative. It was gratifying to note that the use of the trunk system was increasingly popular amongst the Company's subscribers and the public. The increase in messages was not confined to exchange subscribers and renters, but the outside public also largely used the call offices, the number of these latter calls having increased from 273 in December, 1887, to 1,772 in December, 1889, and to 1,968 in March, 1890. The total number of calls on the Company's trunk lines had been as stated below, showing a monthly increase of 442 from September, 1887, to March, 1890: Total calls on trunks, September, 1887, 5,582; September, 1888, 13,597; September, 1889, 15,236; December, 1889, 17,068; March, 1890, 19,295. The calls last March were at the rate of more than 231,000 a year. Each call was answered, so that the number of communications had been at the rate of double these figures, or over 462,000. The cost of trunk lines to the end of 1886 was £11,009; 1887, £18,874; 1888, £29,823; 1889, £38,441; and the earnings of trunks per annum—December, 1886, at the rate of £133; September, 1887, £708; December, 1887, £814; December, 1888, £1,544; December, 1889, £2,302; March, 1890, £2,602. The increase of monthly earnings had been as follows: September, 1887, to December, 1888 (16 months), £836 = per month £52 increase; January, 1889, to December, 1889 (12 months) £758 = per month £63 increase; January, 1890, to March, 1890 (three months), £300 = per month, £100 increase; thus the increase was progressive. Percentage of gross receipts on cost: December, 1886, about 1¼ per cent.; December, 1887, 4¼ per cent.; December, 1888, 5¼ per cent.; December, 1889, 6 per cent. The large increase in calls during the current year gave confident promise of a further advance in this percentage. As yet the trunks had not been a direct source of profit, although the progressive increase in the monthly earnings, and the steady improvement in the percentage that the gross receipts bore to the cost, proved that they were no longer altogether unremunerative; but the indirect value of the trunk system in extending the exchange business of the Company was very great. It was not merely in active business towns like Cardiff and Newport, where the calls amounted to several hundreds a day, that the value of the trunks was shown; but in quiet residential places like Bath, and in business places like Gloucester, where the value of the telephone to many of the subscribers was chiefly the power of communicating with Bristol, Cardiff, and other places; thus in many cases the trunk not only brought in its own revenue, but led to exchange subscribers at each end. This experience made them anxious to extend trunks still further, as they were confident that many places, which were at present quite unproductive, would show a fair amount of business if connected with one or more of their leading centres. Worcester, for instance, had been a disappointing place. After three unsuccessful attempts to establish an exchange, they had now no subscribers there, but were confident that it would help materially when connected with Birmingham in one direction, and with Gloucester and Bristol in the other. As many as 60 firms had promised to subscribe when the connecting trunk was made, and as arrangements were now complete for the connection with Birmingham, it might be hoped that in a month or two Worcester would yield a fair profit. They had lately opened an exchange at Weston-super-Mare, and had already a fair number of subscribers, but they would not have obtained them without the promise of immediate trunk connection with Bristol. On completion of that line, which was now in a forward state, they looked for a large increase in the business at Weston-super-Mare. It was also important to complete the interval between Newton Abbot and Weston, bringing Exeter, Plymouth, and Torquay into direct communication with them. The effect of this would doubtless be to still further increase the Weston business, and that of Exeter and other places; and it would give the opportunity of opening exchanges at Bridgwater, Taunton, and possibly at Wellington, Dawlish, and Teignmouth, with a fair prospect of business. Shrewsbury was another place where a trunk connection was much wanted. Salisbury was at present quite isolated, but by the construction of a trunk line from Bath, via Bradford, Trowbridge, Westbury, and Warminster, and continued to Winchester, these places would be put into direct communication with Bournemouth, Southampton, and Portsmouth, and with the whole of the Bristol and South Wales districts, and a fair amount of business would doubtless result. Without this trunk connection they had hitherto found it hopeless to establish an exchange at Salisbury. With it they might expect fair business there, and probably at Trowbridge and other towns. A further extension of the trunk line from Winchester to the boundary of this Company's district near Reading, when met there as arranged for by the National Company, would place the whole of the principal towns in this district, as well as Bournemouth, Portsmouth, and Southampton, in communication with London, the effect of which could not fail to be very considerable. Another cause of the small net balance was that the auditors had adopted a different plan in dealing with some items of expenditure, charging a larger proportion to revenue than before. This was too technical a matter for explanation there, but it must be evident to every man of business that, in an undertaking like theirs, with some parts of the system fully developed, others partially so, and others again only in an incipient state, and it was only reasonable to expect a difference of opinion as to what portion of the expenditure was fairly chargeable to capital and what applied to revenue. Another cause of the smallness of the balance was that during the year 1889 the progress of their exchange and private line business was less rapid than in 1888. The increase in ordinary receipts in 1888 was £99 per week, and that for 1889 £74 per week, making a difference of about £1,300 in the year. It was not easy to account for this, but it was certainly not to be taken as a sign that the use of the telephone had nearly reached its limit, for during the present year the advance at several of their large centres had been very rapid. For instance, Bristol had increased at the rate of £11 a week, against £7 a week last year, and Cardiff at the rate of £18 a week, against £13 last year. During the first 20 weeks of this year, as compared with the same period last year, the increased receipts from all their exchanges and private lines had averaged £90 per week, and during the last five weeks as much as £104 per week, so that, without venturing to look into the future, they could state as a fact that the exchange and private line business of the first five months of the current year showed a decided improvement on 1889, in addition to the excess of income on trunks already referred to. On the whole, with the improved state of general business, and the adoption of the telephone in all parts of the world, and in many to a much greater extent (as in America)—there were stated to be 300,000 telephones at work—he could not doubt that its use would be greatly extended in this country. There was certainly no reason to be discouraged, for the telephone was now a necessity at their public offices, to police and fire brigades, wholesale and retail merchants, so that as fresh towns were connected by trunk lines there would doubtless be a great extension in its development. But the usefulness of the telephone was not limited to these classes, as was proved by their own experience; thus, at Portsmouth they had 16 hotels connected, at Torquay 11, and at Bournemouth, including boarding-houses, 27; in Bristol and Clifton they had two—the Grand and the Clifton-down Hotels. Why was this? Again, at Bournemouth they had 20 doctors on the exchange, and at Plymouth (the three towns) there were 20; in Bristol nil, and three in Clifton. Private residents were another large class that had very partially availed themselves of the telephone. In proportion to population, Torquay took the lead with 35; Bournemouth had 24, and Plymouth 38. At most of their other exchanges there were very few private resident subscribers. These figures showed that there were large classes that had as yet failed to realise the advantages of the telephone, and he did not doubt that, if more of their large retail businesses were connected, many more private residents would find it to their advantage to subscribe. There was still much ground unworked. For instance, Falmouth and Truro were now asking for an exchange, and many other towns might by degrees desire not to be left out of a system which was spreading over the country.

Mr. H. Fedden seconded the resolution.

Colonel Savile supported the resolution. For so young a company, he felt the dividend they had earned was satisfactory. The business seemed to be growing and increasing in a way they could scarcely have expected. He did not see any charge for the Directors' fees in the balance-sheet for the past year. They ought not to expect them to work for nothing, and at a later stage of the meeting he should move that the sum of £500 be paid to the Directors by way of remuneration.

The **Secretary** explained that they could not insert that sum in the balance-sheet without the sanction of that meeting.

The report was then adopted.

The **Chairman** then moved, "That a dividend of 6 per cent. per annum upon the amounts paid up on preference shares to the 31st of December 1889, be declared, and that the amounts already paid by the Directors on account of such dividend, being the whole amount, be approved and confirmed."

Mr. R. Cory seconded the motion, and it was carried.

Mr. Read proposed the re-election of Mr. Thos. Pole, one of the retiring directors, and the proposition was seconded by **Mr. W. White,** and adopted.

Mr. T. Pole acknowledged the compliment the meeting had paid him.

Mr. Read moved, and **Mr. White** seconded, the re-election of Mr. Henry Fedden, the other director who retired.

The motion was passed, and **Mr. Fedden,** in returning thanks, said that they did not find the directorship of the Company particularly smooth. There were numberless difficulties to be encountered, and unless the Directors followed them closely day by day they could not be of much value to the Company.

The **Chairman** proposed the re-election of the auditors, Messrs. Hudson Smith, Briggs, and Co. They had dealt with the accounts as they believed to be the best for the Company, and they had carefully examined everything.

Mr. R. Cory seconded the resolution, which was adopted, and acknowledged by **Mr. Hudson Smith.** He could sympathise with the desire of the shareholders to pay a dividend upon the ordinary capital, but he was sure they were doing the right thing in withholding it for the present. What had been done with the accounts would tend to the consolidation and welfare of the Company, and in the action they had taken they were perfectly at one with Messrs. Wilton, Jones, and Co., of London, who were experienced in telephone accounts.

The **Chairman** moved that the sum of £500 be added to the reserve fund, making a sum total of £1,700.

Mr. M. Whitwill seconded the resolution, and

Mr. R. Cory, in supporting it, felt that it gave confidence to any commercial concern when it could show a good reserve fund, so that they might be able to meet any contingency that might arise.

The resolution was adopted.

The remuneration of the auditors for the year 1889 was fixed at 95 guineas, this proposition being submitted by the **Chairman,** and seconded by **Mr. Read.**

Col. Savile moved, and **Mr. White** seconded, "That the remuneration of the Directors be fixed at the sum of £500 for the year 1889."

The motion was unanimously agreed to.

The **Chairman,** in returning thanks for the vote, did not hesitate to say that they had well earned their remuneration, and he could fully bear out what Mr. Fedden had said, that the business of the Company required their constant attention.

The meeting was then made an extraordinary one, the **Chairman** explaining that there had been an amalgamation between the National, United, and Lancashire and Cheshire Telephone Companies, and it made it necessary that their articles should be altered by striking out the word "United" wherever it occurred, and substituting therefor the word "National"; and by striking out the figures £30,000 in sub-clause (*a*) of article 71, and substituting therefor the figures £50,000. (*b*) By striking out the words from "The United Telephone Company, Limited, shall also have power," in article 66, to the end of the same article, and substituting therefor the words "The National Telephone Company, Limited, shall have power from time to time to remove both or either of the directors appointed by the United Telephone Company, Limited, or by them, and to appoint other directors or another director in their stead, and so on from time to time. The directors appointed by the United Telephone Company, Limited, or by the National Telephone Company, Limited, shall, *ex officio*, be members of all committees of the board." (*c*) By inserting the words "or the National Telephone Company, Limited," immediately after the words "United Telephone Company, Limited," in article 70 and in sub-clause (*i*) of article 71. (*d*) By inserting the words "or by the National Telephone Company, Limited," immediately after the words "United Telephone Company, Limited," where they secondly occur in article 75. (*e*) By striking out the whole of article 100, and substituting therefor the words "In case the auditor appointed by the United Telephone Company, Limited, or any auditor appointed by the National Telephone Company, Limited, should die, resign, or become disqualified, the National Telephone Company, Limited, shall be entitled to appoint another in his place."

Mr. R. Cory seconded the alterations, and they were agreed to, the confirmatory meeting being fixed for that day four weeks.

Mr. Fedden proposed a vote of thanks to their excellent Chairman for the attention he gave to the Company's business.

This was unanimously passed.

The **Chairman,** in acknowledging the resolution, said he did take a great interest in the Company; but he must not omit to say that Mr. Lewis, their energetic manager, was the mainstay of the concern, and they must thank him for his continued exertions on the Company's behalf.

CONSOLIDATED TELEPHONE CONSTRUCTION AND MAINTENANCE COMPANY, LIMITED.

The ninth annual general meeting of this Company was last week at the City Terminus Hotel.

Sir Alexander Armstrong presided, and in moving the adoption of the report and accounts, said that the latter showed a net profit of £12,714, which, with the amount brought forward from last year, left a balance of £14,272 for disposal, after making provision for doubtful debts. Out of this amount the Directors proposed to pay a further dividend of 7 per cent. per annum for the half-year on the ordinary shares, and of 6 per cent. per annum on the preference shares, making, with the interim dividend, 6 per cent. for the year on both descriptions of shares. They further proposed to write off £543 for depreciation of plant, machinery, and furniture, and £2,000 from the Edison Gower-Bell Telephone Company's securities, thus leaving a balance of £1,842 to carry forward. During the year a further and final payment of £485 had been received on account of profit arising from the liquidation of the River Plate business, which concluded all negotiations in that quarter. He was unable to give any definite information as to the action now pending in Belgium with respect to the patent rights in which the Edison Gower-Bell Company was interested beyond simply stating that the preliminary decisions hitherto had been in favour of that company, with which this Company was intimately allied. It was not unlikely, how ever, that a decision would be arrived at before the long vacation The Anglo-Portuguese Telephone Company showed an increase of 202 subscribers and £1,155 in rental, notwithstanding the differences that had recently arisen between the Governments of this country and Portugal, and the hostile feeling to everything that bore an English name. With regard to the issue of 10,000 preference shares he ought to mention that they had been all taken up rapidly.

Mr. Henry Grewing seconded the resolution, which was carried unanimously.

NEW COMPANIES REGISTERED.

General Electric Power and Traction Company, Limited.—Registered by Ashurst, Morris, Crisp, and Co., 6, Old Jewry, E.C., with a capital of £250,000 in £10 shares. Object: to carry on the business of manufacturers and contractors for the supply of electrical power of all kinds. The first subscribers are:

	Shares.
J. Fenton, 33, Aldershot-road, Kilburn	1
G. S. Everitt, 24, Hartham-road, Holloway	1
W. G. Mackenzie, St. George's Club, W.	1
R. Macpherson, Gowan Lea, Willesden	1
T. Broadley, 2, East-villas, Tottenham	1
R. E. Wall, 21, Kilmain-road, Fulham	1
J. Payne, 2, Walcot-square, S.E.	1

There shall not be less than three nor more than seven Directors.

Qualification, 50 shares. Remuneration, £250 each, with an additional £250 for the Chairman.

Electric and General Investment Company, Limited.—Registered by Renshaws, 2, Suffolk-lane, E.C., with a capital of £200,000 in £5 shares. Object: to promote and facilitate the development of undertakings for electric lighting, electric traction and other industrial purposes connected with electricity. The first subscribers are:

	Shares.
The Duke of Marlborough, 3, Carlton House-terrace	1
J. B. Braithwaite, 27, Austinfriars	20
E. Garcke, 112, Belvedere-road, S.E.	7
G. Herring, 6, Park-crescent, W.	68
B. H. Van Tromp, 4, Hyde-park-terrace	1
A. H. Renshaw, 2, Suffolk-lane, E.C.	1
Lord Cloncurry, Lyons, Hazlehatch, Ireland	1
J. C. Bull, Wilcote, Surbiton	1

There shall not be less than three nor more than nine Directors. The first are the Duke of Marlborough, Lord Cloncurry, J. B. Braithwaite, E. Garcke, G. Herring, and B. H. Van Tromp. Qualification: 200 shares. Remuneration: £700 when the dividend does not exceed 10 per cent., and 10 per cent. of all profits in excess of such dividend, with the proviso that the total remuneration does not exceed £6,000; all such sums to be divisible.

CITY NOTES.

West Coast of America Telegraph Company.—The receipts of this Company for May were £6,075.

Direct Spanish Company.—The traffic receipts of this Company for May were £2,244, against £2,040.

Eastern Extension, Australasia, and China Company.—The receipts of this Company for May were £41,230, showing an increase of £166.

Eastern Telegraph Company.—The traffic receipts of this Company for May were £53,373, as against £52,704 for the same period of 1889, or an increase of £669.

Commercial Cable Company.—The transfer books of this Company will be closed from the 20th inst. until July 2 for the payment of the usual quarterly dividend of 1½ per cent. on July 1.

West India and Panama Telegraph Company.—The estimated receipts for the half-month ended May 31 are £3,184, against £3,053. The February receipts, estimated at £6,619, realised £6,755.

Western and Brazilian Telegraph Company, Limited.—The receipts for the week ended May 30, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,262.

Brazilian Submarine Telegraph Company.—The Directors of this Company have declared an interim dividend of 3s. per share, tax free, being the rate of 6 per cent. per annum, for the quarter ended March 31, payable on the 24th inst. The receipts of this Company for the week ended May 30 amounted to £4,171.

Companies of the Month.—The following electrical companies were registered during the past month:

Bishops Stortford Electric Light and Steam Laundry Company, Limited, £1 shares	£10,000
Electric Welding Company, Limited, £10 shares	460,000
Electric Clean-all Company, Limited, £5 shares	2,000
Electric and General Investment Company, Limited, £5 shares	200,000
General Electric Power and Traction Company, Limited, £10 shares	350,000

PROVISIONAL PATENTS, 1890.

MAY 27.

8197. **Improvements in means or apparatus for the manufacture of wax-coated tablets or cylinders for use in graphophones, phonographs, and the like.** James Yate Johnson, 47, Lincoln's-inn-fields, London. (The Edison United Phonograph Company, United States.) (Complete specification.)

8233. **The extraction of gold from its ores, consisting of a form of copper plate amalgamated with mercury, the action of which in retaining the gold upon it is aided by the passing of a current of electricity.** Walter Alfred Allen Dowden, 281, Vauxhall Bridge-road, London.

8241. **Improvements in electric lamp hangers.** Clarence Leslie Jeffers, 45, Southampton-buildings, London. (Complete specification.)

8242. **Improvements in and relating to electric welding or metal working apparatus.** William Robert Lake, 45, Southampton-buildings, London. (Hermann Lemp, United States.) (Complete specification.)

8253. **Improvements in systems of circuits for electric semaphores.** Jacob Krieger, Frederick Stitzel, Charles Weinedel, Moses Schwartz, Adolph Reutlinger, and John Henry Egelhoff, 18, Buckingham-street, Strand, London. (Complete specification.)

8254. **Improvements in the manufacture of plates for electric accumulators.** Reginald Haddan, 18, Buckingham-street Strand, London. (Frederico Pescetto, Italy.)

MAY 28.

8272. **Improvements in the construction of electrical fire or burglar alarms.** Samuel Benjamin Wilkins, 1, Parliament-square, Edinburgh.

8286. **An improvement in electrical cutouts.** Joseph Torr Todman, Queen-street Chambers, London.

8291. **Improvements in recording dynamometers.** Emery Nixon and Wallace Millichamp, 53, Chancery-lane, London.

MAY 29.

8306. **Improvements relating to electric relays.** Henry Harris Lake, 45, Southampton-buildings, London. (Edward Fitzgerald Law, Russia.)

MAY 30.

8362. **Improvements in electric locomotives.** Edward Dummer, 52, Chancery-lane, London. (Complete specification.)

8379. **Connecting the telephone with the phonograph and telegraph.** William Thompson, Ennerdale House, The Avenue, Linthorpe, Middlesbrough.

8392. **Improvements in tubes or conduits for electric cables.** William Phillips Thompson, 6, Lord-street, Liverpool. (Jacob Frères et Cie., France.) (Complete specification.)

8393. **Improvements in switches for electrical circuits.** Bernard Mervyn Drake, John Marshall Gorham, and Percival John Pringle, 66, Victoria-street, London.

MAY 31.

8427. **Improvements in electric arc lighting.** Alfred Apps, 433, Strand, London.

8442. **Improvements in primary batteries and in apparatus connected therewith.** Sir Charles Stewart Forbes, Bart., 21, Finsbury-pavement, London.

8469. **Improvements in or connected with voltaic battery elements.** The Mining and General Electric Lamp Company, Limited, and Desmond Gerald FitzGerald, 47, Lincoln's-inn-fields.

8471. **An improvement in electrically driven locomotives.** Everard Horne Morgan, 28, Southampton-buildings, London.

8474. **Improvements in electrical switches.** Charles Ambrose McEvoy, 24, Southampton-buildings, London.

8477. **Improvements in electric switches or apparatus for making and breaking electric circuits.** Septimus Felix Beevor, 433, Strand, London.

SPECIFICATIONS PUBLISHED

1881.

4057. **Continuous electric currents in railway carriages, &c.** Newton (Société Universelle d'Electricité Tommasi). (Second edition.) 8d.

5261. **Secondary batteries.** Newton (Volckmar). (Third edition.) 8d.

1882.

2818. **Secondary batteries.** Sellon. (Third edition.) 6d.

1883.

5741. **Secondary batteries.** Sellon. (Second edition.) 6d.

1889.

7808. **Electric alarm attachment.** Julian. 8d.

7894. **Distributing electricity.** Atkinson. 8d.

7895. **Dynamos, &c.** Atkinson. 8d.

9258. **Electric signal lamps.** Rawson and Rawson. 8d.

10695. **Electric batteries.** Lake (Hussey and another). 8d.

10696. **Electric batteries.** Lake (Hussey and another). 8d.

11070. **Secondary batteries.** Johnson (Riker). 8d.

11179. **Electric meter.** Siemens Brothers and Co., Limited (Siemens and Halske). 8d.

11191. **Electric lamps.** Benson. 6d.

15096. **Lampholder and switch.** Rattray and Lowdon. 8d.

20660. **Electric signalling.** Winckler. 6d.

1890.

350. **Electric batteries.** Epstein. 8d.

5087. **Electric cables.** Lake (Barrett). 8d.

5344. **Electric currents.** Lake (Garver). 8d.

5423. **Electric currents.** Wenström. 8d.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Anglo-American Brush	—	2¾
— Pref.	—	2⅛
India Rubber, Gutta Percha & Telegraph Co.	10	20
House-to-House	4½	5
Metropolitan Electric Supply	—	5¾
London Electric Supply	5	2½
Swan United	3½	5½
Crompton & Co., Pref.	—	5½
National Telephone	5	5¼
Electric Construction	10	10

NOTES.

Bacup.—The electric lighting order for the Corporation of Bacup has been issued.

St. Louis.—A hundred miles of electric street railway will shortly be at work in St. Louis alone.

Wrexham.—The Board of Trade have issued a provisional order to the Wrexham and District Electric Supply Company.

Copenhagen.—The authorities in Copenhagen are intending to erect a central electric station, commencing with power for 10,000 lamps.

Electric Traction in Paris.—Experiments on electric traction by accumulators are to be carried out shortly by the Compagnie des Omnibus de Paris.

Woking.—The Woking Electric Light Company are making arrangements for supply of current shortly at a price of 8d. per unit, or 25s. per 8-c.p. lamp a year.

Business.—Messrs. Ewen and Co., 37, Walbrook, have recently been appointed the London agents of Messrs. Charlesworth, Hall, and Co., electrical engineers, of Oldham.

Parts of Dynamos.—The Custom House officials at Turin, it is stated, class the lead plates of accumulators as "parts of dynamos," and charge a tax of six francs per 100 kilogrammes.

Huddersfield.—The electric lighting order for the Corporation of Huddersfield has been issued empowering and requiring the Corporation to lay mains in the principal streets within two years.

Oldham.—The Board of Trade electric lighting order to empower the Corporation of Oldham to lay mains for the supply of electricity by meter to consumers within the borough, was issued last week.

Hopkinson Patents.—We understand that a strong combination of the leading electrical firms is formed to oppose the amendation sought to be obtained for the Hopkinson transformer patents of 1884.

Electrical Execution.—The Supreme Court of New York has refused to interfere with the action of the courts in regard to death by electricity. Kemmler is therefore expected to suffer the death penalty late in the summer.

Barnet.—The Barnet Local Board have written to Mr. Joel, asking whether he intends to comply with the requirements of the Board of Trade. The notice expires at the end of August, just a year before the Board's contract.

Bridlington.—At the last meeting of the Bridlington Local Board, the Building and Lighting Committee reported that they were making arrangements for lighting the Prince's-parade with electricity, to commence from the 14th July.

Manchester and Middleton Tramways.—The promoters of the tramway which is to connect Manchester with Middleton have definitely decided upon the tramway being worked by electricity. The Bill is now before Parliament.

Electric Railroad.—Jay Gould and Cyrus Field, it is stated, are endeavouring to organise a scheme for connecting the towns on Long Island with Brooklyn, by extending the electric railroad which connects East New York and Jamaica town.

Canterbury.—At the Canterbury Town Council, notice was given that at the next meeting an application for a license in connection with the electric light would be moved, and the offer of the Brush Electric Engineering Company would be considered.

Chamber of Commerce.—A meeting of the Electrical Trades Committee will be held on Monday at 2.30 p.m. The questions for consideration are the action of the Board of Trade with reference to overhead wires, and statistics as to the volume of electrical trade in the United Kingdom.

Electric Soldering.—Prof. Elihu Thomson has recently patented an invention which applies the principles of electric welding to soldering and cementing. By this process the parts are put together and properly shielded, the electric current is applied, and the parts fused together under pressure.

Stockton.—The Corporation of Stockton are determined to be well in the van of electrical progress and to have their own central supply station. On the recommendation of the Finance Committee, it was decided to make application to the Local Government Board for sanction to borrow £25,000 for the erection of central electric lighting works.

Sheffield.—In October last the Sheffield Town Council passed a resolution instructing their Parliamentary Committee to consider and report upon the desirability or otherwise of applying, under the Electric Lighting Acts, for power to supply electricity within the borough. At the last meeting of the committee it was resolved to recommend the Council to proceed in the matter.

Shall Gas Works Supply Electricity?—This question will probably be treated in a paper by Mr. A. F. Gray before the meeting of Gas Engineers to be held at Ryde next week. The conclusion of the author is in favour of gas engineers taking up the supply of electricity. We have more than once discussed this question and pointed out that gas companies have great facilities for supplying electricity.

North Metropolitan Tramways.—The Unopposed Bill Committee of the House of Lords have passed the North Metropolitan Tramways Company's Bill, which gives power to that company to work their system by electrical power. The Bill also sanctions the raising of £100,000 additional capital, with power to borrow any sum not exceeding £25,000. This Bill has now received the sanction of both Houses.

Scotland.—The Electric Lighting Acts Amendment (Scotland) Bill was read a second time in the House of Commons on June 5th. Sir G. Trevelyan mentioned in the House that, upon the footing that this Bill would be proceeded with so as to enable the Board of Trade to proceed with the electric lighting provisional order of the Corporation of Glasgow, that Corporation had withdrawn that portion of their Bill now before Parliament relating to electricity.

Folkestone.—Some difficulty has arisen with regard to the time of breaking up streets in Folkestone, Messrs. Crompton saying that they could not guarantee the light should be ready by 1st January, unless they could have authority to break up the streets on the 1st August. This it was thought, not unnaturally, would be suicidal for a seaside town, and it was agreed to arrange with Messrs. Crompton as to the time of starting, but under no conditions were the streets to be opened before 1st October.

Westinghouse and Pullman.—It is understood, says the *Electrical World*, that Mr. George Pullman, the car-builder, and Mr. George Westinghouse, jun., are about to form a company to construct electric street railways on a large scale. The main office will be in Pittsburg or Chicago. It is said that Mr. Westinghouse is now in Chicago settling the details of the combination. A site will be taken near the works of the Pullman Company for the manufacture of motors. Many New York capitalists are said to be interested.

Train Lighting in India.—The proposal to light the mail train between Calcutta and Umballa with the electric light, which was dropped some time ago, has again, says the *Indian Engineer*, been under the consideration of the railway authorities, and its adoption now is merely a matter of time. The chief point remaining to be settled is whether the light shall be supplied from storage batteries in the carriages or by a dynamo worked from the engine. Experiments will probably be made in the first instance on the old East Indian loop line.

King's College Evening Classes.—A large company assembled on Friday evening at King's College, on the occasion of the annual distribution of prizes to students at the evening classes of the college. Mr. W. H. Preece, F.R.S., an old student of the college, distributed the prizes. Among the list of prizes, Mr. A. P. Cummings was awarded the prize for electricity and magnetism. The principal of the college, Dr. Wace, remarked that 800 students attended the lectures. After the distribution Mr. Preece delivered an interesting address on "Fashion."

Montevideo.—An interesting state of things was mentioned at the meeting of the Montevideo Gas Company at Cannon-street Hotel. The chairman, Mr. A. K. Mackinnon, in the course of his remarks, stated that the town had recently increased very much, and the greatly improved well-being of the people had also benefited the company. Order and economy had set in in the administration of the country's resources; and in illustration of this he said that the municipality was paying the company the full amount they owed them monthly, although this was a reduced sum owing to the number of public lamps taken up by the electric light.

Burton-on-Trent.—At the Burton Town Council, Alderman Lowe, in moving the adoption of the Gas Committee's report, said the Board of Trade had granted the provisional order asked by the Corporation for supplying the town with the electric light, and the gas manager was about to issue a circular asking the inhabitants whether they desired to use the illuminant, so that the committee might be guided in the provision they would have to make. A charge of 8d. per unit was proposed to be made at first, but if they found they could make a reduction as they proceeded a recommendation to that effect would be forthcoming.

Cheltenham.—The draft provisional order, as altered by the Board of Trade, has been accepted by the Cheltenham Town Council. This order had been prepared on the lines of the Swansea order, under which three areas are prescribed, the first an area within which electrical energy must be provided within two years; the second, that within which the Corporation were compulsorily obliged to supply it on certain conditions; and the third an outer area of voluntary supply. The Local Government Board accepted only one area, within which the Corporation would be protected by adequate safeguards, and this area was now defined and agreed to.

Overhead Wires.—In the House of Commons on Monday, Mr. Dixon-Hartland asked the Attorney-General whether the new electric light companies in London were legally empowered to disfigure the streets and greatly increase the risks of fires by putting their wires overhead instead of underground. The Attorney-General: Under the Electric Lighting Acts of 1882 and 1888 powers are reserved to the County Council and to the Board of Trade for regulating and controlling the cases in which overhead wires may be used, and, in my opinion, these powers are sufficient. The information before me does not tend to show that overhead wires increase the risk of fires.

Electric Traction in Liverpool.—The Liverpool Tramway Company having obtained permission from the Health Committee of the Corporation, made a first experiment on Tuesday with an electric storage car to ascertain with what success electricity as a motive power could be utilised in that city. An accumulator car left the Walton depot at four in the early morning, and made the round trip to the pierhead. With a full complement of passengers the car was tried on the Water-street gradient, and gradients and curves were traversed with speed, comfort, and safety. The experiment was made under the guidance of the Electric Traction Company's engineer, Mr. Thomas Fraser.

The British Association.—The first general meeting will be held on Wednesday, September 3, at 8 p.m., when Prof. W. H. Flower will resign the chair and Sir Frederick Abel, president-elect, will assume the presidency and deliver an address. On Thursday evening, September 4, at 8 p.m., there will be a *soirée*; on Friday evening, September 5, at 8.30 p.m., a discourse on "Mimicry," by Mr. E. B. Poulton, M.A., F.R.S., F.G.S.; on Monday evening, September 8, at 8.30 p.m., a discourse on "Quartz Fibres and their Applications," by Prof. C. Vernon Boys, F.R.S.; on Tuesday evening, September 9, at 8 p.m., a *soirée*; and on Wednesday, September 10, the concluding general meeting will be held at 2.30 p.m.

French Inventor of the Telephone.—In the speech with which M. Jules Roche, the Minister of Commerce, opened the International Telegraph Congress, he claimed for a Frenchman, M. Bourseul, the honour of inventing the telephone. M. Bourseul was put on the retired list in 1887 by M. Granet, then Minister of Posts and Telegraphs. He was at that time departmental director. Twenty years before the American inventors he is said to have laid down the rules for working the telephone. He was received on Wednesday by M. Jules Roche, and has been entrusted by him with the mission of ascertaining what improvements can be introduced in telephones. M. Bourseul is a Chevalier of the Legion of Honour.

Edison Lamp Patents.—The lawsuit brought by the German Edison Company against Messrs. Naglo, of Berlin, was decided in the favour of Messrs. Naglo upon the decisive report of Prof. Kohlrausch. In his report, Prof. Kohlrausch stated that it was impossible to make an incandescent lamp according to the Edison patents of 1879, and that it was not until after the publication of Swan's patents that a practical incandescent lamp could be manufactured. Moreover, the report says that constructions similar to those of Edison existed before the granting of the 1879 patents, and that a filament of carbon thinner or thicker could not form the basis of a true patent. It is thought on the Continent that the judgment of such a world-wide authority as Prof. Kohlrausch will make the French Edison Company reflect before continuing suits which it is understood are begun or contemplated in France.

Electric Welding at Newcastle.—Some highly interesting and successful experiments were made on Tuesday with the Thomson welding machines, at the works of Messrs. Clarke, Chapman, and Co., of Gateshead, before a number of local gentlemen, some of whom are taking a financial interest in the new company. Stay-bolts, 1¼in. diameter, were welded in 43 seconds, as against 5½ minutes by the ordinary process, tried immediately afterwards on similar bolts. The freedom from dirt in the weld was also commented upon as a great point in favour of the new system. Only two firms in England have as yet obtained these machines, the other being the London and North-Western Railway Company, who have them at work at Crewe. In Messrs. Clarke, Chapman's works the machines are in charge of an ordinary workman, until lately totally unacquainted with the process, and the firm express themselves highly satisfied with the result.

Polechko Disc Dynamo.—The following details are given of the Polechko dynamo, a new dynamo of the Thomson and Ferranti type, recently introduced by M. Polechko and described before a Russian congress of physicists. The armature is a thin plate of metal, very thin, some 3ft. in diameter, divided radially into 360 sections, revolving between four field-magnets. The periphery is fitted with a steel band put on hot, which serves as collector, the brushes being placed one at the periphery and the other at the axle. The magnetic intensity in the air space was 6,500 C.G.S. units. The dynamo, weighing 22½ cwt., gave 2,000 amperes and 25 volts at 1,600 revolutions. This was an experimental dynamo. It is intended to introduce commercial machines on this principle. Electrical engineers will no doubt be interested in the practical type of such machines; a specimen at work would be an exhibit such as the electrical exhibitions ought to attempt to secure.

Bristol.—A long discussion upon the question of the establishment of a central electric station took place at the Bristol Town Council on Tuesday. The Mayor stated that upon the recommendation of Mr. W. H. Preece, F.R.S., the committee who had been considering the question proposed to invite tenders for experimentally lighting the central part of the city. The committee's recommendation met with much opposition, it being argued that the day for experimenting with the light was passed. It had been established in many towns in the West of England, and they should go in for a larger scheme than the committee proposed. The Council were of opinion that the Corporation should undertake the supply themselves, and not allow any company to step in and establish a monopoly such as they suffered from in regard to their gas and water supplies. Upon the question being voted upon, an amendment was adopted by a large majority that the Electrical Committee should bring up a large scheme of supplying the city with electricity, and at the same time keeping the supply in their own hands.

Central London Railway.—The Bill for the Central London Railway was discussed on Friday last before the House of Commons, the objections of the local tradesmen being insisted upon, but not sustained. Mr. J. Rowlands said the House ought to express an opinion that in future when a committee had to consider a Bill of this description it would be expected to make some terms for the community. In this case the company proposed to go to so great a depth that they did not require to take any premises on the surface, and thus they avoided the ordinary difficulties of compulsory acquisition. But the community had some interests in these railways, which were the railways of the future, and it ought to be understood that in the form of a royalty or in some other way the rights of the community should be preserved, and should not be altogether parted with to private companies, a remark which was applauded. The Bill was put down for the third reading. In connection with this question, the Queen, who is a large owner of property in Oxford-street, has in that capacity been pleased to sign her approval of the Central London Railway scheme.

Which Shall We Believe ?—The Chairman of the Eastern Extension Company is reported to have said at the last meeting of shareholders that the out-of-pocket cost of telegraphing per word to Australia was 4s. 10d., and yet, according to his own letter to the *Times*, dated June 5, a 4s. rate has been provisionally arranged. On April 23, then, it was impossible to telegraph at less than 4s. 10d., but on June 5 it was possible, and was promised. To ordinary individuals such rapid progress is amazing. How is the loss to be made good ? Is the Eastern Extension to be amalgamated with the Eastern ? Are the directors going to give up the loaves and fishes ? Has some new method of increasing rapidity of signalling been devised—or what ? Why does not the subsidised organ illumine the dark abyss of irreconcilability of language ? Will there be a profit on the 4s., or is it certain there is to be a loss of 10d. per word ? If it costs 4s. 10d. per word, increase of the number of words will only make matters worse. Were the negotiations for reduction going on at the time of the meeting ? Was the same man who made the statement responsible for the negotiations ? Of course, we shall be told, if told anything, that it was a mistake in figures, or a calculation based upon no increase of words.

Height of Arc Lamps.—Herr F. Uppenborn, the well-known German electrician, editor of the *Elektrotechnische Zeitschrift*, writes to us with reference to the calculation of M. Kopcke given in our issue of the 30th ult., with reference to the best height of a luminous point. The same calculation, says Herr Uppenborn, was made by him in 1880 and published in the *Zeitschrift für angewandte Elektricitätslehre* (later the *Centralblatt für Elektrotechnik*), vol. ii., p. 384. Though this formula cannot be applied in all cases in actual practice, as the intensity of light in arc lamps is so very different at different angles, yet he believes the formula to be of special use, because by help of this formula it can be proved that arc lamps in most cases are hung too low, if the best lighting of the ground be considered. According to this formula, an angle of 35deg. with the horizontal is the limiting angle for greatest distance; but the maximum power of the arc lamp is to be found generally in arc lamps at an angle of 45deg. with the horizontal. If we intend to obtain the maximum lighting effect we must make the height of suspension equal to the radius, so that the angle becomes 45deg. In a very great number of cases it is not possible to do this, and it often occurs that the greatest height we can give for the suspension point is $h = 0{\cdot}7r$.

Electrical Control of Distant Signals.—It frequently happens that the electrical control of a distant signal from the station or the box is interrupted through the electric wire coming in contact with another line, or with earth; and although the distant signal shows "line clear," the alarm bell in the signal-box begins ringing as though the distant signal stood at "danger." To obviate this, Herr F. Gattinger, chief inspector of the Austrian State Railways, has introduced an apparatus consisting of an induction coil, the hammer of which makes contact with a freely swinging pendulum, and is so constructed that one stroke per second is given. This apparatus is connected with the distant signal, and is closed and protected against any outside influence. The electric alarm bell in the signal-box is arranged so that it can receive its electric impulse solely through the closing of the circuit by the apparatus at the distant signal, and therefore can only give strokes at intervals of one second. If the circuit is closed through any outside influence, the alarm does not sound, and the hammer lies quietly against the bell as before. These strokes at intervals of one second are much less trying, it is said, both to officials and passengers than the continuous ringing of the ordinary electric bell; absolute safety and reliability in the working of the signals is secured; and all needless consumption of the elements of the electric batteries is avoided.

General Electric Traction.—Lord Bury in a letter to the *Financial News*, answering a critic of the new electric traction company, combats the statement that the company cannot succeed because it adopts the accumulator system—all successes, it being suggested, in America have been won by the overhead system, and the accumulator system has uniformly failed. "This," says Lord Bury, "is not our experience; our accumulator system has proved successful, and we have adopted it, first, because we have succeeded in making it work, whether others have failed or not; and, secondly, because the tramway authorities prefer the accumulator system, and the local authorities, speaking generally, will not permit the use of overhead or underground wires. But if the views of the writer of the article should prevail, and the local authorities should prefer at any future time to use the overhead system—which, as the writer points out, has been successful in America — my company is prepared, at any moment, to supply installation on the overhead system, because we control the patents for the Sprague system, the success of which the writer of the article so ably describes. We do not, as I said, agree with him in anticipating non-success for the accumulator system. But if tramway and other authorities prefer the overhead, we are ready, and we cannot help thanking the author of the article, who has very ably vaunted our wares without, I fancy, bearing the General Electric Traction Company any good-will."

Column Printing Telegraph.—We described some months ago what cannot but prove a distinct advance, almost a revolution in distributive telegraphy, the column printing telegraph of Messrs. Moore and Wright, in which the telegraphic news is printed much as a type-written letter instead of strip. Ingenious, quite as simple as other telegraphic machinery, and thoroughly worked out in details, these machines have been practically at work for some time at the Houses of Parliament and elsewhere. A company has now been formed to work this invention, with a capital of £100,000, in £1 shares, of which half are offered to the public. Sir William Thomson has reported very favourably upon the new machines, saying that they will be found very exceedingly valuable in many important departments of actual telegraphic practice. The machines are already in use in newspaper offices and clubs, and are likely to widely extend, as the practical advantage is felt and acknowledged at once. The directors estimate that, assuming that only 500 machines are rented, a return of not less than 15 per cent. on the capital invested may be expected. The Central News has agreed to use these machines exclusively for seven years, and in return will furnish the company with a full supply of news, thereby relieving the Column Printing Company from the heavy cost for an independent collection of news. The company acquires Messrs. Moore and Wright's patents for £30,000, of which £20,000 is in cash.

Seeing's Believing.—"Visitors to the metropolis must have been struck with the number of private installations of the electric light, more especially between Ludgate-circus and Charing Cross. Nearly every newspaper office has its electric plant, and we hear that the light has given satisfaction to that army of workmen who labour during the night and small hours of the morning to supply the public with news. The most recent addition is in the new offices of the *Field* and *Queen* newspapers, which are situated in Bream's-buildings, Chancery-lane. An engine, indicating 120 h.p., has been erected, and the electric plant is being fitted up by the Fyfe-Main Electric Lighting and Construction Campany. Arc and incandescent lamps are to be used in the machine-room, and incandescent lamps in the offices and compositors' room. It is worth noting that this firm has fitted up more newspaper offices with their system than any other firm in existence. Amongst others it has supplied the *Telegraph*, *Standard*, *Daily News*, *People*, and *Daily Graphic*. With reference to the last-named establishment, it may be stated that the proprietors found they could not accomplish the work of producing a daily illustrated newspaper without the use of electricity. By its aid a pen and ink sketch can be photographed in three minutes, and in five minutes the plate is ready for etching. Who would have said ten years ago that the electric light should become a necessity for the production of a daily illustrated newspaper!" The above is extracted complete from the *Gas World*. "A necessity"—yes, this is the correct phrase, and not only for newspapers. We may reiterate the question, "Who, indeed?"

The County Council and Overhead Wires.—The Bill of the London County Council, which asks the sanction of Parliament for further powers in regard to subways now belonging to them, the making of new or additional subways in streets, and for controlling, regulating, and prohibiting the use of overhead wires in London, was on Wednesday before a select committee of the House of Commons, under the presidency of Sir Joseph Bailey. The Chairman said as several clauses had been struck out of the original Bill, it would be a matter of convenience if counsel would use the new Bill only. Mr. Pember, Q.C., pointed out that part of the Bill had been abandoned, and now related to overhead wires alone. He then proceeded to address the committee in favour of the scheme. He then called Mr. Beachcroft, a solicitor, and member of the County Council, who said he had taken great interest in the question of overhead wires. A year or two ago a Bill was promoted by the United Telephone Company, now the National Telephone Company, one of those opposing this scheme, which was to give power to the company to carry overhead wires under proper supervision, but that Bill was dropped. He was of opinion that there should be some authority in control over the wires; many of the wires in the metropolis were much too long without any support. In case of a fire in a building with a pole and a number of wires attached upon the roof the danger to the public would be very great, as it would in the event of a great snowstorm. He would take the wires underground whenever possible, but there were cases where overhead wires must be taken. He thought the County Council the best body to have the supervision of the wires.

Frankfort Exhibition.—The arrangements for next year's electrical exhibition at Frankfort-on-Main are being pushed forward with considerable energy. We have received a plan of the town of Frankfort, showing the site of the exhibition within easy distance of the banks of the Main, and also the plan of site of the exhibition. Arrangements are now being made for a series of technical congresses to be held during the time of the exhibition. The first is a general congress of the electrical engineers of Frankfort; for the second the Municipal Council of Frankfort invite all the German municipal councils for a congress to be held at Frankfort, dealing with the inspection and testing of different systems of electric lighting traction and transmission of power. The third will be an invitation to the congress of gas and water engineers, now being held at Munich, to hold their next meeting at Frankfort. The fourth will be a congress of German scientific men. One of the largest exhibitors will be the firm of Schuckert and Co., of Nuremberg, now one of the most prominent of German electrical firms. Among the exhibits promised by this company are numerous and different dynamos for special purposes, one of which will be a dynamo of 500 h.p.; electric lighting for theatres with a new regulating system for stage lighting; electric lamps for lighthouse work; different installations for ship lighting; electric railways connected with ordinary street distributing mains; transmission of power a distance of 12 miles; running of workshops by electric motors; demonstration of different systems of electric distribution; and, lastly, the lighting of a grotto with some specially novel beautiful and surprising effects.

Electric Lighting of New Scotland Yard.—The new central offices of the Metropolitan Police on the embankment are being fitted throughout with the electric light. Altogether some 1,260 incandescent lamps will be employed to light the 300 rooms and multitudinous corridors and passages. In order to obviate any risk of a total extinction of the light from any cause, the wiring, which will require altogether about 15 miles of conductor, is arranged with alternate lamps on different circuits supplied by separate engines and dynamos. A special feature will be the arrangement of the lights in the various offices, in each of which all the connections will be made with twin flexible conductors, which will start from a distributing box over the door and run separately to the pendant lamps across the ceilings on the surface of the plaster, the twin cables being held in place by small insulating eyes. This arrangement has been specially designed to suit the construction of the building, in which all the floors are of the parquet description laid on solid concrete, and the exigencies of the police requirements, which necessitate from time to time alterations in the positions of the lights. It was at one time proposed to obtain current from one of the public supply companies, but having regard to the large size of the installation and the importance of the lighting being entirely independent of labour disputes or such other troubles as might affect an outside source of supply, it has now been determined to put down a special generating plant with which on the considerable scale required it will be possible to manufacture the electric energy at a price considerably below the 7½d. per unit demanded by the supply companies. The generating plant will consist of three Lancashire boilers and four sets of engines and dynamos, having a combined power of some 160 electrical h.p., and will be placed in a special underground engine-house excavated outside the main building so as to avoid the possibility of the noise or heat causing any nuisance in the latter. There will also be a battery of accumulators capable of maintaining 200 lights for nine hours when the engines are at rest. The installation, which will be one of the largest and most complete of the kind in London, is being carried out to the specification of Mr. A. A. Campbell Swinton, A.M.I.C.E., who has been appointed by the Home Office to superintend the whole undertaking.

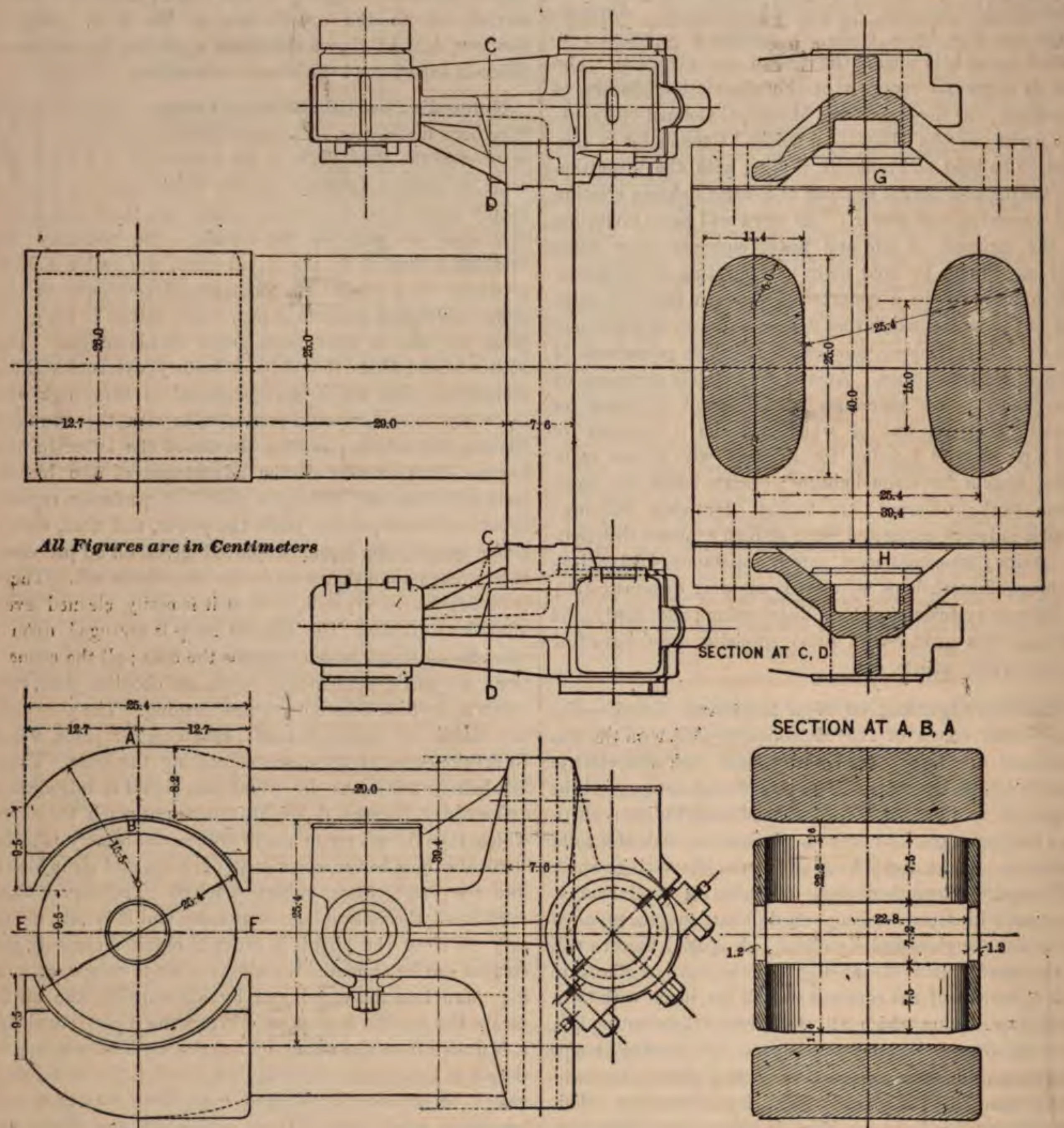
Renard's Portable Electric Lamp.—Many attempts have been made, says *L'Industrie Moderne*, according to the abstract in the *Proceedings* of the Institution of Civil Engineers, to obtain a primary battery which could be used to supply current to an electric lamp, but there are many objections to most of the forms. The necessity for constant attention to the liquid used, the feeble E.M.F. produced by a single cell, the want of constancy in the power developed, and the objectionable nature of the gases given off, are in most cases great disadvantages. The author states that the Renard battery overcomes these difficulties; that the E.M.F. produced is very high, and there are no acid vapours produced, as with the two-fluid Bunsen cell, which prohibits the use of the latter in the house. It possesses all the advantages of the bichromate cell, with the difference that it is perfectly regular in action, developes five times the power, and that, with a given weight, the liquid employed gives off 50 per cent. more energy than that used in the bichromate cell. There is no deposit of crystals, so that it is easily cleaned even after long disuse. The electric lamp is arranged upon a vase-shaped stand, which contains the cells; all the connections are made permanently upon an ebonite plate, the surface of which does not require cleaning. The glass cells are sealed by means of sockets into a copper plate, which forms the cover of the vessel containing the cells. There is a hole in this cover by which the liquid is introduced, and when at its normal height it does not reach the zincs, which thus do not waste away. When the battery is to be used, the hole in the cover is stopped up, and air is blown into the vessel by an indiarubber ball. The liquid then rises in all the cells at the same time, and it is only necessary to close the circuit in order to obtain a current; the current can be regulated by allowing air to escape, or forcing more into the vessel, and by allowing all the air to escape the current is stopped. When the liquid is used up, it is drawn from the vessel by a syringe. The whole is as simple as an ordinary domestic lamp, and, if the containing vessel be occasionally washed with clean water, it will remain in good order. Those which are now made are provided with seven cells and a glow lamp, supported on a stalk rising from the vessel. The main particulars are:

Total weight, including liquid	35·2lb.
Height of battery without lamp	15in.
,, ,, with ,, ...	33in.
Diameter of vessel..............................	11¾in.
E.M.F. of battery	10 to 11 volts.
Strength of current	4 amperes.
Watts produced..................................	40 to 45.
Candle-power of lamp	25.
Duration of light normal	5 hours.
,, ,, maximum	8 ,,
Price of materials for one charge	2s. 1d.
,, light per candle-power per hour...	0·2d.

MAGNETIC DATA OF THE SPRAGUE STREET CAR MOTOR.*

BY H. F. PARSHALL.

Figures giving the ratios of the lines of force through various parts of the magnetic circuit to the lines of force through the armature have occasionally been fully published, the most noticeable being those given in a paper by Hopkinson some years ago. These ratios vary in the same type of dynamo or motor with any change of proportion; or, to put it in another way, in order that these ratios may remain constant in the same type, the ratios of the magnetising force in the one part of the magnetic circuit to the magnetising force in the other parts must also remain constant.



All Figures are in Centimeters

FIG. 1.

In making calculations on various motors made by the Sprague Company I have found it necessary to confirm the assumed values of these ratios by measurements. It is the object of this paper to give the results of the measurements made on the street car motor, together with sufficient description to make the values found of some use to those engaged in similar work. If I had had any intention of publishing these results I should have endeavoured to make them in some ways more complete than they now are; but so little detailed information exists on this subject that I have decided to give the result of my work up to date on this particular motor. The conditions under which this work has been carried on have not at all times been the most favourable for accuracy, but in the main the results have been satisfactory.

Figs. 1 and 1A show the various peculiarities of the magnetic circuit, and give the dimensions of the several parts. The most noticeable points are:

The bell mouthing of the pole-pieces shown in the section A B A. This bell mouthing greatly lessens the sparking, as does also the cutting away of the tips of the pole-pieces, as shown in A B. With these modifications the brushes can be shifted an angle of 20deg. without serious sparking.

The other noticeable points are the cast-iron side brackets, the width of the yoke and its comparative thinness.

The method of getting the ratio of the lines of force in one part to the lines of force in another was the usual one. Coils of a few turns were wound around these parts, and connected to a ballistic galvanometer, and when the needle was standing at zero a known magnetising force was suddenly reversed.

The galvanometer used was an Edelmann with a heavy ring form of needle, very slightly damped. The deflections being small, it was assumed that the first throw was proportional to the induction through the measuring coil. The magnetising coils were those commonly used on this motor.

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* A paper read before the American Institute of Electrical Engineers, Boston, Mass., May 21st, 1890.

Each coil was wound approximately to a depth of four centimetres, and along the cores 8·5 centimetres.

Coils were as follows:

1st. Nearest the pole-piece, 28 turns per layer, 11 layers.
2nd. 31 turns per layer, 11 layers.
3rd. 31 turns per layer, 13 layers.

This gives 2,104 turns for both cores, or with a current of 6·75 amperes, which was used throughout, a magnetising force of 14,200 ampere-turns.

By noticing the curves in Fig. 2 it will be seen that this is the part of the characteristic upon which the motor is most frequently worked. With different values of magnetising force different values of the ratios would be found.

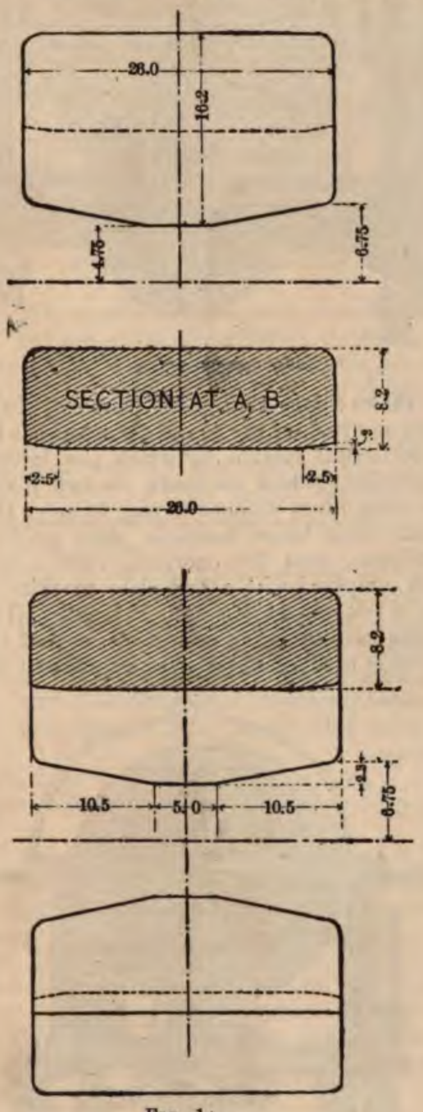

Fig. 1a.

This becomes evident when we remember that the resistance of the gap remains constant, while the resistance of the iron increases with the magnetising force. For this reason the curves of magnetisation of the different parts of the magnetic circuit are not given.

The measuring coils were four turns of wire wound around the armature core at E F, on the pole-piece; at A B, on the magnet core, midway between the ends and on the yoke at G H; had it been possible a coil would have been wound around both the yoke and side brackets.

The following values were found:

$$\left.\frac{\text{Lines through magnet}}{\text{Lines through armature}}\right\} 1{\cdot}45$$

$$\left.\frac{\text{Lines through middle of yoke}}{\text{Lines through armature}}\right\} 1{\cdot}27$$

$$\left.\frac{\text{Lines through middle pole-piece}}{\text{Lines through armature}}\right\} 0{\cdot}666$$

Cast-iron pole-pieces:

$$\left.\frac{\text{Lines through magnet}}{\text{Lines through armature}}\right\} 1{\cdot}52$$

$$\left.\frac{\text{Lines through middle of yoke}}{\text{Lines through armature}}\right\} 1{\cdot}33$$

$$\left.\frac{\text{Lines through middle pole-pieces}}{\text{Lines through armature}}\right\} 0{\cdot}7$$

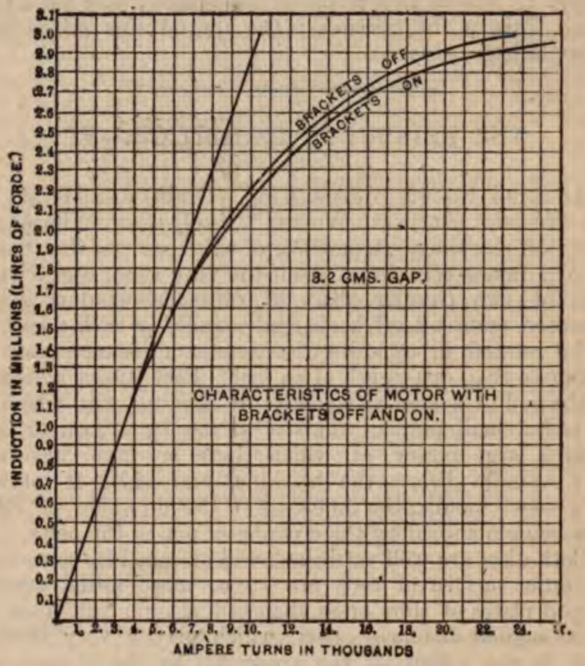

Fig. 2.

The effect of the leakage from the side brackets is shown in Fig. 2, the upper curve being the characteristic with them removed, and the lower curve being the characteristic with brackets on. The dropping of the curve shows that the magnet cores are sooner saturated with the brackets on. The difference is small. It would be somewhat greater did not the brackets reinforce the yoke. These curves were first obtained by separately exciting the fields, and taking the number of revolutions, with a driving current of one ampere through the armature.

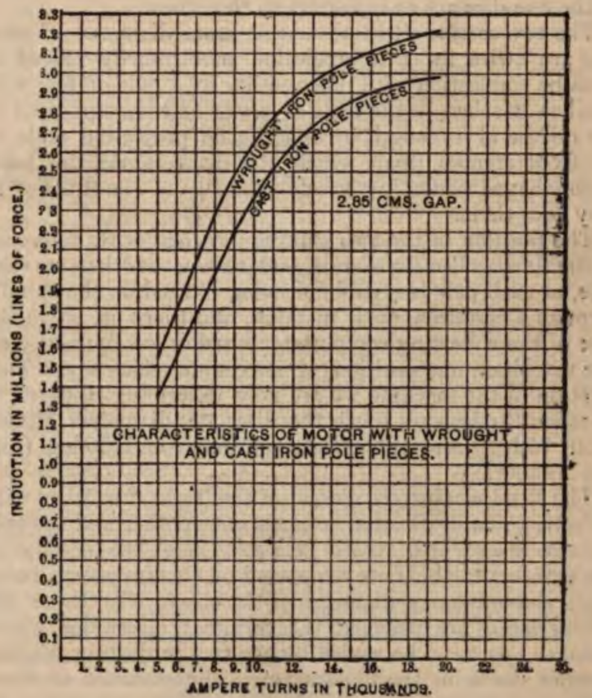

Fig. 3.

The lower curve has, by comparison, been found to be a close approximation to the characteristic when the armature is run with currents for which it was designed.

Fig. 3 shows the characteristics of two motors, one with the wrought-iron pole-piece and the other with the cast-iron pole-piece, the gap being 2·85 instead of 3·2, the side brackets being on in both cases. The difference between these two characteristics is somewhat striking, and carries its own lesson.

I wish here to acknowledge my indebtedness to Mr. G. J. Scott for the assistance he has given me in making measurements.

Fig. 1A shows two forms of pole-piece; one has a full line. This is the cast-iron: the dotted line shows the wrought-iron pole-piece.

THE EDINBURGH EXHIBITION.—VI.

At stand No. 99, Messrs. King, Mendham, and Co., of the Western Electrical Works, Bristol, show Wimshurst electrical machines. A machine of this type was first made by Mr. James Wimshurst about the year 1880, and it consists of two circular discs of ordinary window glass, mounted upon a fixed horizontal spindle in such a way as to be rotated in opposite directions at a distance apart of not more than one-eighth of an inch. Each disc is attached to the end of a boss of wood, or of ebonite, upon which is turned a small pulley. This is driven by a cord or belt from a large pulley, of which there are two, attached to a spindle below the machine, and which is rotated by a winch handle, the difference in the direction of rotation being obtained by the crossing of one of the belts.

Both discs are well varnished, and attached by cement to the outer surface of each are 12 or more radial sector-shaped plates of thin brass, disposed around the discs at equal angular distances apart, which play a very similar part in the action of the apparatus to the "carriers" of Nicholson's "revolving doubler," and those of the "replenisher" of Sir William Thomson; but it would appear that they do more than this, and that they take the place of the "inductors" in both of these instruments, for there is nothing else in Mr. Wimshurst's apparatus to correspond with those parts, and it is probable that the carriers of the one disc act as inductors to the other.

The two sectors situated on the same diameter of each disc are twice in each revolution momentarily placed in metallic connection with one another by a pair of fine wire brushes attached to the ends of a curved rod, supported at the middle of its length by one of the projecting ends of the fixed spindle upon which the discs rotate, the brass sector-shaped plates just grazing the tips of the brushes as they pass them.

The position of the two pairs of brushes with reference to the fixed collecting combs, and to one another, is variable, as each pair is capable of being rotated on the spindle through a certain angular distance, and there is, as in the case of the collecting commutator brushes of dynamo-electric machines, one position of maximum efficiency. This position in the machine we are now describing appears to be when the brushes touch the discs on diameters situate about 45deg. from the collecting combs, and 90deg. from one another.

The fixed conductors consist of two forks, furnished with collecting combs directed towards one another and towards the two discs which rotate between them, the position of the two forks, which are supported on ebonite pillars, being along the horizontal diameter of the discs. To these collecting combs are attached the terminal electrodes, whose distance apart can be varied by the two projecting ebonite handles shown in the illustration. The presence of these collecting combs appears to play no part in the action of the apparatus except to convey the electric charge to what may be termed the external circuit, for the inductive action of the machine is quite as rapid and as powerful when both collectors are removed, and nothing is left but the two rotating discs and their respective contact or neutralising brushes.

Machines are also constructed by the firm with ebonite cylinders (see Fig. 2). This form is adopted as ebonite is liable to change its shape if used as a flat plate. These machines are provided with Leyden jars, which fit into cups mounted on mahogany, and stand close to the conductors, thus obviating any loss of electricity through the chain usually employed for connecting them up. Indeed all the machines are so fitted now. The firm exhibit machines of various sizes, both with glass plates and ebonite cylinders, from a large machine consisting of six 30in. plates down to a machine carrying two 9in. ebonite cylinders.

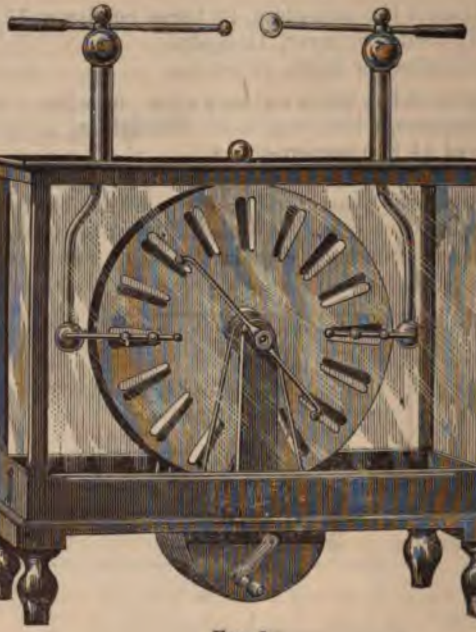

FIG. 1.

Fig. 1 shows a four 15in. plate machine. In it the electrodes are so fitted on the top of the case that they have a circular horizontal motion, by which the lecturer or exhibitor is enabled to show the spark in two planes at right angles to each other, without having to move the machine. The sparks from these multiple plate machines possess great brilliancy from the enormous volume of electricity generated compared with a two-plate machine; the spark, however, is not much increased in length. The two ends of the glass case are made removable, so that the whole of the interior is easily accessible for adjustment of brushes.

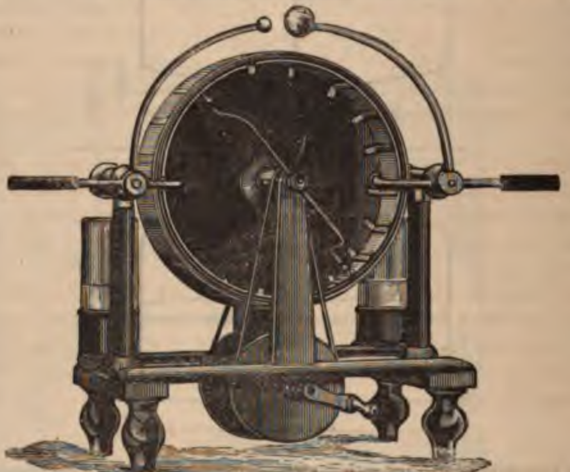

FIG. 2.

Messrs. Walter T. Glover and Co., Salford, Manchester, at stand No. 46, show examples of the various classes of insulated wire and cable, and of high-conductivity wire and strip, which they guarantee to be not less than 98 per cent. of purity.

In two of the sample cases are short pieces of telephone and telegraph cables, armoured and unarmoured, for use as aerial or underground cables, and among them we specially notice their patent anti-induction telephone cable, which is now in operation in London and most of the provincial telephonic centres. This cable is exceedingly light, and is therefore specially suitable for overhead work. It is weatherproof and waterproof, and stands climatic changes very well. It is styled anti-induction cable, because the makers claim for it that when properly erected there is little or no cross talk, none of those disturbing noises which are such a nuisance to telephone subscribers generally, and which on long lines at times actually prevent steady conversation. This desirable result is obtained by means of a special method of insulation on the individual conductors, and by external coverings of metallic tape, which, being put to earth at intermediate points of the line, carry off disturbing currents and leave the wires free for the telephone current only. Besides this advantage to the public, there is another for the electrical engineer, as by a special system of numbering any individual wire can be found at either end when the cable is in course of erection, and is therefore all the easier to connect up.

Besides the above, this firm exhibit samples of electric light cable in large variety for various requirements, such as underground, overhead, and inside houses, shops, mills, and such like. They also show metallic covered cables and armoured cables for rough usage and submarine use.

There are some interesting samples of the deep-sea cables of the earlier days, shown in a separate case, not as manufactures of the firm, but as being of interest in tracing the development of telegraphy. Visitors would find it of interest to visit Messrs. Glover's stand and then visit the Post Office stand, where the instruments used in the earlier days are on view. Besides the larger cables, there is a nice collection of fancy covered wire of all sorts for different branches of the electrical trades, amongst which may be noticed the elegant twin wires used in suspending or connecting electric lamps in offices, mansions, and houses generally.

This firm claim to supply a special wire, which they style "Compactum," for dynamo makers, which combines high conductivity and complete insulation with the minimum thickness of covering. There are several coils of this wire on the stand.

Railway engineers will be interested in the sample of three conductor cable used for coupling up the carriages when lighted by electricity. The sample referred to has 1,000 fine wires in each conductor, fine wires being essential in order to get great flexibility.

Coils and samples of the firm's patent covered iron and hard-drawn copper wire are exhibited. This covering, as it prevents the action of the weather on the wires, makes them last much longer than they otherwise would. Sample coils of bare hard-drawn high-conductivity copper wire are on the floor, along with some lengths of tinned wire and cable. There is also a length of tape copper, this being used largely now in dynamo construction, as it enables the dynamo manufacturer to get on to his machine a greater weight of copper than he could if he used a circular wire or cable.

Visitors will notice in the large show case a coil of No. 40 gauge bright copper wire, weighing upwards of 7lb., in one continuous length. This is unusual for such a fine wire.

This firm are also makers of a special wire gauge, which not only gives the diameters of the wire in inches and millimetres like the usual screw gauges, but also the number of each wire from No. 1 to No. 40. It also gives the area in square inch of the various sizes, and from this can be calculated the weight, resistances, and capacity of any size from No. 22.

PADDINGTON AND THE ELECTRIC LIGHT.

A well-attended meeting of the members of the Paddington Vestry who are opposed to the granting of any provisional order for electric lighting in Paddington this session, was held at 15, Connaught-square on Tuesday, June 10, 1890, Mr. Mark H. Judge in the chair. Among the members present were Mr. W. H. Mills, Mr. Wm. Rayner, Mr. John Hills, Mr. Chas. See, Mr. Halford Mills, Mr. S. Townsend, Mr. W. H. Stewart, Mr. U. Maggs, Mr. Britton, Mr. W. Marrell, and Mr. J. G. Hunt.

The **Chairman** read the reply of the Board of Trade to the memorial opposing the provisional order and asking for a local enquiry. The reply stated that "after careful consideration of the memorial, the Board of Trade are not of opinion that a local enquiry is necessary in respect of the application of the Metropolitan Electric Supply Company, to which the consent of the Vestry had been duly given." Mr. Judge then read a letter which he had addressed to the Board of Trade on June 5th, controverting the methods of procedure by which the Metropolitan Electric Supply Company had obtained the provisional order from the Board of Trade, asking for copies of the present rules of the Board of Trade, and the provisional order proposed to be given. Mr. Judge also said, "I shall feel obliged if you will inform me of the date of the communication from the Vestry clerk from which the Board of Trade have learnt of amendments asked for by the Vestry." The Board of Trade replied to this letter by sending the documents asked for, and in their letter stated that "the amendments were amendments which the promoters informed the Board of Trade they understood the Vestry desired to have made in the order."

After full discussion of the whole matter the following resolutions were unanimously passed :

1. Proposed by **Mr. Wm. Rayner** and seconded by **Mr. W. H. Stewart**: "That this meeting approves of the letter addressed by the chairman to the Board of Trade on June 5, and, while thanking the Board for having given careful consideration to the memorial in opposition to the granting of any electric lighting provisional order for Paddington during the present session, is unable to agree with the statement of the Board that 'the consent of the Vestry has been duly given' to the application of the Metropolitan Electric Supply Company; and under all the circumstances of the case, this meeting is of opinion that no Paddington order can be properly granted before the session of 1891."

2. Proposed by **Mr. J. Britton** and seconded by **Mr. John Hills**: "That the Board of Trade be informed that the promoters of the Metropolitan Electric Supply Corporation, Limited, have never been authorised by the Vestry to communicate with the Board on the Vestry's behalf, and that any proposals which the said promoters have forwarded to the Board have never been considered or approved by the Vestry; and this meeting hereby expresses its astonishment that the Board of Trade should be content to receive its information as to the views of the local authority through the medium of outside promoters."

3. Proposed by **Mr. W. H. Mills** and seconded by **Mr. Charles See**: "That steps be taken to oppose any Bill for confirmation of the granting of a provisional order for electric lighting in Paddington during the session of 1890, and that in the meantime the Board of Trade be respectfully asked to explain how it can be held that the consent of the Vestry, even if given on May 29th, can be regarded as complying with the rules under the Acts, and why the memorialists in opposition are not entitled to a local enquiry under Rule XI., having regard to the following provisions:

"The Act of 1882, section 5, provides that the rules made by the Board of Trade shall 'be of the same force as if enacted by this Act, and shall be judicially noticed.'

"The Act of 1888, section 1, gives authority to the Board of Trade to dispense with the consent of the local authority in certain cases, but in each case where this action is taken the Board 'shall make a special report stating the grounds upon which they have dispensed with such consent.' In the case of Paddington no such report has been issued, and indeed the Board agreed that they would not Act until the consent of the vestry had been given in accordance with the Act.

"Rule VII. provides that the approval or consent of any local authority must be given by resolution passed at a special meeting held after one month's notice, and 'the fact that such a resolution was duly passed must be proved by furnishing a certificate signed by the secretary or clerk of such local authority.'

"Rule XIV. provides as follows: 'The parliamentary agents or solicitors for the order must be prepared to prove compliance with the provisions of the Acts *and these rules* by the 25th of January, and *all such proofs* must be completed on or before the 25th of February.' The resolution of the Vestry by which it is said the consent of the Vestry has been duly given was passed on May 29. How proof of this could have been completed by the 25th of February has not been explained.

"Rule XI. provides as follows: 'In *all* cases of applications for a license, renewal of license, or provisional order, to which objection is made by any person locally interested, the Board of Trade will, if either the applicant *or the objectors* so desire, hold a local enquiry, of which due notice will be given.' The objectors to the Paddington order this session are locally interested, not only as large ratepayers but as members of the local authority; and on the same day that the local authority decided to withdraw its opposition notice of opposition was given to the Board of Trade, and request made by the objectors for a local enquiry. On what ground is the provision of this rule to be set aside in this case?

"As already stated, the rules are to have the same force as the Acts, and though the Board may rescind, alter, or repeal such rules, notice of the same has to be given to Parliament. It does not appear that the Board of Trade has any authority to ignore either the rules or any provisions of the Acts, and were it otherwise it is obvious that the rules would fail of their purpose; indeed, unless the rules are to be adhered to, the public interests would be better protected with no rules, as then the ratepayers, knowing the position, would act accordingly. As it is they naturally expect that the rules will be adhered to."

4. Proposed by **Mr. Halford Mills** and seconded by **Mr. Townsend**: "That the chairman be requested to forward copies of the resolutions to the President of the Board of Trade."

A vote of thanks to the chairman concluded the proceedings.

APPOINTMENT.—Mr. Albion T. Snell, M.I.E.E., M.I.C.E., has been appointed works manager and chief engineer to the General Electric Power and Traction Company, Limited.

ELECTRIC LAUNCHES AT EDINBURGH.—These launches, running on the Union Canal, are proving very attractive at the Edinburgh Exhibition. For the week ending last Saturday 6,024 passengers were carried, earning in 2d. fares £93. 7s. 10d., while the cost of running was £29. 10s.

THE
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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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IMPORTANT NOTICE.

We may occasionally follow the lead of our American Contemporaries, especially when they point out a serviceable way. They are not backward in asking their friends to do all they can for the welfare of the paper. We ask our friends to remember us. No paper that we know ever refuses Subscribers or Advertisers. Nor do we; in fact, we invite them, believing that they will get full value for their money.

Specimen copies of the paper will be sent on request.

CROMPTON v. ELIESON.

The result of the proceedings in this action is given elsewhere. We listened to most of the evidence given during the five days the case was argued, and must confess some surprise at the verdict. An immense amount of irrelevant matter was imported into the case, the greater part of which the judge in his summing up brushed aside, and left four questions to the jury. The first of these was the most important, and in effect was to decide the relation holding between Messrs. Crompton and Co. and the Elieson Company. The former contended they were merely managers, the latter that they were contractors. No written agreement existed, merely the "minutes" of a conversation as written by Mr. Gower, the secretary of the Elieson Company. These minutes specifically mentioned that Messrs. Crompton were to "manage," but one or two letters referred to by the judge seemed to indicate, and we presume from the verdict did indicate to the jury, that Messrs. Crompton originally interpreted the term "manage" in a wider sense. It was, perhaps, unfortunate for them that neither counsel had referred to these particular letters, and so no explanation of the wording could be given. The other questions for the jury to consider were as to "accident," "error of judgment," or "negligence," with regard to certain breakdowns that occurred. The breakdowns admittedly happened (1) because of something wrong with the accumulator, Messrs. Crompton contending that a connection broke, Messrs. Elieson that the accumulator was not properly charged; (2) because of the breakage of two wheels, due to the wrong construction of points; and (3) from the stripping of the teeth of a rack. The Elieson Company contended that negligence occurred in not entirely renewing the teeth of the rack, especially as attention had been directed to it by one of the directors. Some teeth had been renewed, and it was admitted that had all the teeth been renewed the breakdown might not have occurred. It is exceedingly dangerous to traverse the finding of a jury, but in the latter case we can hardly see where or how negligence came in. An error of judgment if you like, but when it was proved that the rack was overhauled and all the teeth thought to be dangerous removed, the case can scarcely come into the category of negligence, yet the jury so brought it in. The judge in his address to the jury was extremely jocular at the expense of scientific witnesses, yet one piece of evidence, if completely elucidated, would have set at rest any doubt as to the "charge" or "want of charge" of the accumulator. One witness stated that the breakdown *must* have been through a broken connection, because the set of accumulators had been subsequently tested for current. No results of this test were brought forward or, as we say, they would have dissipated all doubt. If the tests showed the accumulators contained the ordinary charge, it was proof positive against their being uncharged. We leave the case at present because the time is hardly favourable to discuss one or two interesting points under dispute, especially as to what constitutes an independent contractor or a firm acting as a manager. The verdict has been given and must be respected.

MORE TRACTION COMPANIES.

We understand that a company will shortly come before the public for a large capital to carry out certain contracts which have been made with tramway lines to work them with electric traction. Contracts have already been made to the extent of £300,000, and the company will need at least a million and half of capital. The systems of traction to be used are those of Thomson-Houston and the series system. Undoubtedly tramway companies are earnestly watching the developments being made, and it only needs a few successful installations to ensure a very large business. The great success of electric traction in America must have its influence in England, although the conditions holding there are generally somewhat more favourable to such a system than those existing here. It is absolutely certain that tramway lines can be satisfactorily worked by electricity, and it is high time that the so-called experimental lines, which are neither fish, flesh, nor fowl, were relegated to the archæological museum. They are never satisfactory and never can be. What is required is a responsible company to undertake electric tramway and railway work upon a large scale, and this is just what the company referred to intends to do.

CORRESPONDENCE.

THE LANE FOX PATENTS.

To the Editor of the Electrical Engineer.

Sir,—I enclose for your information a copy of a letter which we are sending out to all undertakers using the Lane Fox system of distribution, offering them terms for the use of the patents.

As to private installations, a circular will be issued shortly in much the same words; but instead of the terms given as *a*, *b*, *c*, a royalty will be charged of 3s. 6d. per 16-c.p. lamp per annum.—Yours, etc.,

C. A. Stephenson.

2, Princes-mansions, S.W., 10th June, 1890.

[copy.]

Lane Fox Electrical Company, Limited,
66, Victoria-street,
Westminster, S.W.,
10th June, 1890.

Dear Sir,—1. You are doubtless aware that your company is making use of the Lane Fox patent for electrical distribution, No. 3,988** of 1878.

2. This patent, together with all the Lane Fox patents, are now held by this company.

3. My object in writing is to inform you that this company is prepared to grant a license to your company as undertakers; and I have to offer the choice of the following methods of payment of royalty for the use of the patent:

- (*a.*) By a payment of ½d. per Board of Trade unit supplied to consumers.
- (*b.*) By a payment of one-eighth of a penny per Board of Trade unit supplied to consumers. Such payment to continue after the expiration of the patent for such a term as would render the payment equivalent to *a*, taking all risks into consideration.
- (*c.*) By a capitalised sum, payable partly in cash, partly in shares of your company; the sum to be arrived at on the basis of *a*.

4. On an agreement being entered into, we shall be prepared to give your company as undertakers an indemnity for having used the patents prior to 31st Dec., 1889.

5. This company will also consider such an agreement as final, and will not make any further claim in respect of any patents for distribution, regulation, secondary batteries, and motor-dynamo distribution, taken out by Mr. Lane Fox during the years 1878 to 1883.

6. You will understand that these terms are offered without prejudice. No period is at present definitely fixed within which we shall require your acceptance, but this company reserves to itself liberty to withdraw these proposals at any time after the 16th inst.

BRUSSELS CENTRAL ELECTRIC STATION.

Official Form of Tender.

[Translation.]

The undersigned .... submits tender for the establishment of an electric supply system at Brussels, on the conditions indicated in the Scale of Charges, herewith annexed and signed, and of which the Article 20 (relating to repurchase of plant by the Brussels authorities) is worded as follows: [Details to be here filled in].

Note to Persons Tendering.—In the case where the price of repurchase should comprise an annuity, this should be fixed by taking as basis the total or a fraction of the mean net revenue of the three previous years. This net revenue being the difference between the gross receipts on the one part, and the expenses of working the renewals, the interest at 4 per cent. on the capital sunk and the depreciation on the other part; these latter being calculated as follows:

a. Upon the buildings	1½	per cent.
b. Upon the distributing mains	3	"
c. Upon the machines, meters, and apparatus	5	"
d. Upon the accumulators	10	"
e. Upon the tools	20	"

The town will have at any time the right to free itself from the annuities by making over to the undertakers the equivalent capital calculated at the rate of 4 per cent.

Between the town of Brussels, represented by A... on the one part, and B... on the other part. It is hereby agreed as follows:

Article 1.—The town of Brussels concedes to the contractor, of the second part, who accepts, the exclusive privilege of laying in the public way a system of mains, having for its object the electric lighting of the streets and of the houses upon all the territory of the town.

These mains may serve at the same time for the supply of motive force, and for other industrial applications.

Except where express permission of the Corporation in special cases is given the mains will be underground.

The privilege granted will not prevent the town preserving or installing in the streets for public lighting, or for the service of the municipal buildings, such mains or distribution as it may think fit.

Art. 2. The present concession is granted for a term of 25 years, to commence from the day of the adjudication of award.

Art. 3. The undertaker will erect one or more central stations, with the necessary distributing mains, in such a manner that he will be able to satisfy every demand for the supply of electricity within one year from the date of such demand.

He will not be bound, however, to satisfy these demands unless they attain the amount of 250 watts per decametre of street mains to be added to the existing mains.

He will not be bound to lay more than five kilometres of mains before the end of the first year.

ART. 4. The Corporation may authorise the undertaker to place the mains within certain sewers; and will determine the conditions of such an arrangement.

They may also insist that certain streets should have double sets of mains.

ART. 5. The undertaker is authorised to take water from the Willebroeck Canal, or from the reservoirs appertaining thereto, on the condition that during the months of May, June, July, and August he should return to the canal, in a suitable state of purity and at a suitable temperature, the water taken for the purpose of condensation. If at any other period of the year this restitution of the water is judged necessary, the undertakers will be bound to do this upon the simple notice of the Corporation.

ART. 6. The undertaker is bound to supply the current on the conditions of supply which are attached to this agreement, and which form an integral part of it, to every person who will undertake to sign an agreement for at least two years.

If the existing machines suffice, the current must be supplied within three weeks of the demand.

ART. 7. The undertaker is bound to supply and fix, at the price determined by the police tariff, electric meters on the system agreed by the Corporation.

ART. 8. The current is to be on at every hour of the day and night at the disposition of the customer.

If interruptions are necessary for the work of repair or inspection, these shall not take place without the express authority of the Corporation.

ART. 9. For the public lamp posts the undertaker will furnish the current, the maintenance of branch wires and lamps, globes and lanterns, the lighting and extinction of the lamps at the hours fixed by the administration, at the following prices:

Per incandescent lamp of 16 c.p., burning till midnight, per hour of lighting, 4 centimes (0·4d.).

Per arc lamp of 12 amperes, burning till midnight, per hour of lighting, 50 centimes (5d.).

If the lamps employed are of a different power, or the period of lighting is modified, the town will pay—more or less, as the case may be—the value of the current supplied, and this at the price of current furnished to private customers diminished by 50 per cent.

ART. 10. For every public lamp which, according to the reports of the agents of the administration, has not burned properly during the whole evening, there will be deducted as penalty at the next settlement, per evening, a sum 50 centimes (5d.) for each incandescent lamp, and 5f. (4s. 2d.) for every arc lamp.

ART. 11. The price of supply of current in buildings of which the lighting is supplied by the town is fixed at the price of supply to private customers, but with a rebate of 20 per cent., and on the same conditions.

ART. 12. The undertaker will pay annually to the town, in the two last months of the working year, 10 per cent. of the gross receipts, or a corresponding amount of current and hire of meter. No exception will be made of the supply made to municipal buildings or public lighting.

ART. 13. The undertaker will not be allowed to commence any work upon the public way, or in his works, without having previously submitted plans and obtained the consent of the Corporation.

In case of urgency, by reason of an accident or inspection the work will be allowed, but notice must be at once given to the Corporation.

ART. 14. The undertaker will be bound to carry out at his own expense all alterations of position of mains judged necessary by the Corporation.

He will pay all costs of road construction necessitated by the running or removal of mains, and in case of delay, the Corporation shall have the right of carrying them out themselves at his expense.

ART. 15. The undertaker declares himself solely responsible to the town authorities, as well as to any third parties, for all damages resulting from his works, installation, or mains, whatever be the cause thereof, and without recourse to any suit against the town under any count whatever.

ART. 16. The members of the Corporation and their delegates are to have, at all times, access to the whole of the premises of the undertaker, and are to be allowed to inspect the books and accounts.

The annual balance-sheet, the accounts of the first cost of erection, and the profit and loss account are to be submitted, every year and before they are definitely closed, to the examination of the Corporation. If any observations are made on the subject of accounts, the company will be bound to submit to the decision of three experts, nominated as hereinafter mentioned, Art. 17, second paragraph.

The plans of the distributing mains are to be kept up to date, as well as a register, showing the number, kind, and power of lamps in use for each customer.

The undertaker is to place at the disposition of the Corporation all the workmen and instruments necessary for testing either outside or inside the works.

ART. 17. The undertaker will be liable to forfeit his concession:

1. If he does not satisfy one or other of the obligations herein undertaken;

2. If it is decided, upon the report of three experts, nominated, the first by the town authorities, the second by the undertaker, and the third by the president of the Tribunal, that the supply does not accord with the exigencies of a good service;

3. If the undertaker suspends payment.

ART. 18. In case of forfeiture, as also at the expiration of the concession, the undertaker will be bound to remove, at his own expense, within the period prescribed by the Corporation, the whole of his installation and the distributing mains upon or under the public way, and to make good the ground to the previous state, the whole to be officially directed and carried out by the Corporation themselves if they so think fit.

The undertaker will be bound in case of forfeiture, if the town so directs, during a delay not exceeding two years, to maintain and carry on the existing service, in order to permit the establishment of a fresh service without interruption to the supply. If the undertaker be not satisfied with this obligation, the town is authorised to take provisional possession of all installations and to assure the service officially at the cost and risk of the undertaker.

Two years before the end of the concession the town will have the power to authorise the carrying out of any work upon the distributing mains in the streets, in view of a public supply of electric light.

ART. 19. The town to have the right, upon giving notice of this intention within two months of the forfeiture, or within one year of the expiration of the concession, to take back all or part of the sites, buildings, machinery, mains and apparatus belonging to the undertaker, at the decision of experts nominated according to Art. 17, paragraph 2.

These experts will value the objects so taken over at their actual value at the date of taking over.

The sums due will be paid within three months of the handing in of the report of the said experts, half the cost of such expert advice being paid by each party.

ART. 20. Without prejudice to the rights provided for in Art. 19, the town may also take over, at any period, after one year's notice, the whole of the installations and mains belonging to the undertaker, and, if desired, the whole or part of the accessories.

The town can, however, refuse to take over the plant which exceeds by 50 per cent. that necessary for the number of lamps or apparatus habitually in use, including the reserve plant.

During the year which will pass between such notice and the time of taking over, the undertaker will not be allowed to extend his plant without the assent of the Corporation.

The price of repurchase will comprise: [Details to be filled in].

ART. 21. By the fact of repurchase, provided for in Arts. 19 and 20, the town will be substituted for all rights of the undertaker, both for the leases of the sites, for the licenses, or for any other count, the undertaker being guaranteed against any obligation whatever.

In the case of such repurchase or taking over of the works, the town will have the right to take possession, even before the expert report, in order to prevent any interruption of service.

ART. 22. Within one week of the definite award of the present contract, and before the commencement of work, the undertaker will pay to the Communal Treasury as caution-money in specie the sum of 100,000f. (say, £4,000). This caution-money is to serve as guarantee of the carrying on of all obligations of the present contract, and will cover, in case of need, the sums due to the town for official work, damage, interest, fines, etc.

In case the undertaker does not conform to the obligation of the preceding paragraph, the Corporation will have the right to declare by simple notification the forfeiture of such concession.

If, owing to payments, the caution-money be diminished, the undertaker will be bound at the first demand to complete the sum.

The town will pay annually to the undertaker interest at the rate of 3 per cent. upon the portion of the caution-money remaining intact.

ART. 23. Without prejudice to the stipulation in Art. 17 every transgression of the clauses of the present contract renders the undertaker liable to a fine of 100f. (£4).

Every delay of the undertaker in fulfilling one or other of his engagements, remaining after 24 hours' notice not fully carried out, renders the undertaker liable to a fine of 100f. per day for each infraction.

ART. 24. The undertaker has no power to make over all or any part of his enterprise, nor the whole or part of his plant or material, without the previous consent of the Corporation. The same prohibition applies to the lease of premises, or to the formation into a company. In this latter case the articles of association must first be approved by the Corporation, and no modification of the same will be allowed without the same authorisation.

ART. 25. For the execution of the contract, the undertaker declares his address in Brussels to be Rue ——.

ART. 26. The cost of stamps, of registering, of collection of fines arising out of the present contract will be at the charge of the undertaker.

ART. 27. The present contract will not be definite as to that which concerns the town of Brussels until after the approbation of the Communal Council.

Given in duplicate at Brussels, this —— day of ——, 1890.

(To be continued.)

THE LIMITATIONS OF STEAM AND ELECTRICITY IN TRANSPORTATION.*

BY O. T. CROSBY.

"Do you expect electric engines entirely to displace steam locomotives on all railroads ?" That is a question which has doubtless been propounded to many electrical engineers. Its answer has doubtless been made in general by wise reference to the boundless possibilities of direct production of electrical energy from heat, and to Bellamy's "Looking Backward" storage batteries.

To make some study of the boundary line dividing the province of steam locomotion from that of electric locomotion, under existing conditions of producing electric energy, is the object of this paper.

In the light of present achievements I may state, without argument, the following propositions :

First. It is possible to construct motors capable of doing the maximum work required to-day in transportation.

Second. It is possible continuously to generate electric energy equal to the capacity of any number of such motors.

Third. At any desired loss and over any desired distance it is possible to supply by the running contact method, the necessary current, at considerable pressure, for the working of such motors.

Should there still be question in the minds of any as to the value of the running contact method at speeds much higher than those commonly used, I may state that I have seen 75 amperes at 500 volts thus continuously supplied to a car moving at more than 110 miles an hour.

The premises being established, further discussion divides itself into three parts.

First, as to the mere possibility, without reference to the economy, of steam and electric propulsion under given conditions.

Second, as to the relative cost of exerting, in a locomotive, any unit of power by electric, as compared with direct steam motors.

Third, as to the relative amount of power required by the two agents to transport a given paying load under given conditions.

In using the word steam, as above, I have in mind only the direct application of steam power on the tracks. The case of cable propulsion is not here compared, as that has, within its restricted field of application, already been compared with horse, steam, and electric power.

The limiting possibilities of locomotion may be understood by considering a prolongation of the lines of present practice in the direction, first, of loads handled ; second, grades climbed ; third, speeds attained ; fourth, length of continuous runs.

Since the effect of grade, as compared with line, is simply to increase the tractive effort required for a given load and speed, it need not be separately treated, except that there has been some question of increase of adhesion, in the ground return method, which in extreme cases might appear as an advantage for electric propulsion. The matter is not of great importance, and I will refer to it only so far as to say that interpreting my own general experience and some special tests, the adhesion coefficient seems not increased in any practical degree by the mere passage of the current from wheel to rail.

The capacity of an electric engine, like that of a steam-engine, to haul any given load, will be measured by the tractive effort possible to be produced, and the relation between weight and adhesion for given track conditions. The ready multiplication of cylinders in the one case and armatures in the other, while maintaining mechanical unity as to drawbar division and the ready coupling of distinct locomotive units, renders the whole question of capacity to exert a given horizontal effort, without regard to the time element, unimportant and indefinite.* It goes without saying that, if desired, a single armature may be constructed capable of exerting as great a drawbar strain as any locomotive now in use.

As to limiting speeds, it is not easy to-day to make "an educated guess" either for steam or electric propulsion. The high figures for steam that have been recently presented, both from England and America, are higher than the limiting figures as they would have been given by many competent authorities only a few years ago. Eighty-six miles per hour in England on the North-Eastern Railway, 87 miles per hour in this country on the Reading Railway, have both been reported since January 1, 1890. These runs are noteworthy, not only for the fact of unusual speed, but because, as shown by indicator cards in the English case, and as may be deduced from the consideration of the maximum cylinder power in the American case, the train resistances are far below the values that would have been predicted by even the most liberal of the received formulæ on the subject. The total resistance per ton, as per indicator card in the 86 mile run, was only 13·4lb. According to Searles' formula, adopted by Wellington, it should be 69lb., engine and tender being taken at 50 tons. The load of 347 tons was carried at 86 miles per hour by an expenditure of 1,068 h.p., this on a level. The engine was compound.

Would it be possible to attain a speed twice as great, or, say, 150 miles per hour ?

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* A paper read before the general meeting of the American Institute of Electrical Engineers, Boston, Mass., May 20, 1890.

* As an interesting example of an unusual load in steam service, I may refer to one consisting of 156 loaded cars and two cabooses, hauled over the Mississippi Valley Railway, December, 1885. The load consisted of—

	Pounds·
Cotton weighing	3,226,00
Cars weighing	3,239,000
Engine and tender weighing	147,000
Speed was about 10 miles per hour,	6,612,000

A driver 24ft. in circumference would require to revolve 550 times per minute in order to travel 13,200ft. per minute, or 150 miles per hour, this without slip. Since in the case considered the revolutions per minute reached 309, and since in the Reading case a much higher rate must have been reached, the drivers being smaller, and since on stationary engines a speed much above 550 revolutions per minute has been attained, it seems beyond question that from this point of view the supposed case is quite possible.

Considering the matter of steam supply, we are again brought to consider the whole matter of train resistances at all speeds.

Total resistance to motion should be sharply divided into two classes: the resistance due to motion through air, and that due to friction and blows between vehicle and track, and to friction and blows between parts of the vehicle.

For the most part those who constructed the formulæ now found in text-books worked on roadbeds far inferior to the best work of to-day, at speeds much less than those now attained and with wrong values for at least one of the species of resistance, the atmosphere. On this point I have recently been able to present as the results of experiments at high velocities, made by Mr. Benj. J. Dashiell, jun., and myself, a formula showing the pressure to be a function of the first, instead of the second, power of the velocity as ordinarily assumed. A convenient datum point may be given stating that at 100 miles per hour the pressure on one square foot, normal to the direction of motion, is 13lb., while proper shaping of the front may reduce this 6·5lb.

The absolute values given, while corresponding quite closely with those of received formulæ in the neighbourhood of the velocities heretofore experimentally attained, depart widely from those assumed for velocities higher than 30 miles per hour, and calculated by the quadratic relation between velocity and pressure. Using the more trustworthy values, I have been able to separate more nearly than has heretofore been possible the atmospheric from all other resistances met at high velocities. Some inaccuracy still remains, by reason of the difficulty of obtaining exact measure of the resisting areas in a train, but I have been able, by study of careful tests made by others on the N. Y. Central and on English roads, to find that over the range from about 40 up to 80 miles per hour the tonnage coefficient seems practically constant at 8lb. This, of course, applies only to first-class roadbed and rolling stock. Whether this coefficient remains constant at higher speeds we do not know. There is no reason to assume, as has often been done, that it increases with the square of the velocity, and on the other hand it will not be safe to assume constancy. From experiments made with a single 2·5 tons car at about 100 miles per hour, the tonnage resistance at that speed seems to be about 20lb. per ton. Though this value seems quite high as compared with the 8lb. at 85 miles per hour, the difference is in large part to be explained by the poor condition of the track used for the experiment and a constant curvature which would call for about 4lb. per ton. Until better evidence can be had, it will be safe, at least, to assume a value of 20lb. per ton, on a first-class track, with good rolling stock at 125–150 miles per hour.

Having made this necessary digression, we may return to the matter of steam supply, and state that by reducing weight and area, both to something less than one-half the original values in the 86-mile run, the same effort would produce the speed 150, instead of 86. The area cannot be thus reduced, but by assuming a greater reduction in weight—say, to 100 tons, or to little more than engine and tender—maintenance of the higher speed becomes possible, with nearly the same steam expenditure as in the recorded case.

To attain that speed from rest might require such original weight of fuel and such length of favourable track as to make the feat practically impossible with steam. This leads us to enquire into the dead weight necessary for hauling, say, one ton at different speeds.

Table I. gives the horse-power required for exerting the tractive effort for one ton at various speeds, at various efficiencies, with various values of cross-section per ton, and with the two agents—steam and electricity;

Column 1 shows speed in miles per hour from 20 to 140; column 2, corresponding tonnage coefficient, or resistance, in pounds per ton, inclusive of atmospheric resistance. Columns 3 to 8 inclusive show horizontal effort needed for overcoming atmospheric resistance under various assumptions as to area exposed per ton, from 1 square foot to 0·1 square foot per ton. The former figure corresponds nearly to the case of a heavy locomotive propelling itself alone. As load is put on behind it other ratios are formed. Oblique surfaces are supposed to be reduced to equivalent normal surfaces. Columns 9 to 14 inclusive show rate of work in horse-power per ton for the various cases of area exposed to atmospheric resistance, efficiency of locomotive being taken at 90 per cent. Columns 15 to 17 inclusive show horse-power per ton for the extremes and middle cases of exposed area, and for locomotive efficiency of 80 per cent. Columns 18 to 20 inclusive show same for efficiency of 60 per cent. Columns 21 to 26 inclusive show weight of coal and water per ton carried for one hour, assuming 5lb. of coal and 15lb. water per horse-power hour on a steam locomotive. The coal figure is very close to actual practice. The water figure is less, but makes allowance for scooping water at convenient intervals. Continuous scooping is not considered practical or economical. Columns 27 to 29 inclusive show weight of steam locomotive and tender required to generate the required horse-power per ton, under the assumption of 100lb. per horse-power and 90 per cent. efficiency. Only three cases of exposed area are taken—that is, one foot, one-half a foot, and one-tenth of a foot per ton. The weight of steam locomotives is not calculated for any other efficiency figure than 90 per cent., as this seems to be quite constantly attained or surpassed. The assumption of 100lb. per horse-power is closely true for many good types of locomotive when working at speeds from 60 to 80 miles. At lower speeds this figure is too low, but it is assumed that for any ruling speed engines may be built of minimum weight for that speed. In passing through lower than ruling speeds, both electric and steam motors work at low output per pound of weight, hence the assumption of constant weight per horse-power will not introduce error materially affecting comparative results. At higher speeds than 80 miles existing engines would show less than 100lb. per horse-power; but as their boiler capacity is reached at that speed, the necessary increase for any regular work would carry the weight figure to very nearly the figure given for the 60 to 80 mile running. Columns 30 to 32 show weight of steam locomotive and tender, plus weight of fuel and water per ton hauled, also weight of load-freight and freight car that may be hauled; by such weight of motive power; the load figures being obtained by subtracting the motive power weights from 2,000lb. Columns 33 to 41 show corresponding figures for electric locomotives under the assumption of 60lb. per horse-power, and at the three efficiencies, 90, 80, and 60 per cent.

The 60lb. per horse-power covers weight of containing car for motors. I cannot here go into detailed figures on this point, but believe that any investigation will find the figure safe, supposing always that the unit be, say, 25 h.p. or more. I also know of experimental work now progressing under most competent direction, which gives fair promise of leaving this figure much too high. Columns 42 to 53 inclusive show the horse-power required to be exerted for hauling one ton of *load*—*i.e.*, freight and freight car, the relation between these two being taken as the same for either steam or electric propulsion; hence not necessary to enter here. These columns apply to steam at 90 per cent., and to electricity at 90, 80, and 60 per cent., and for the three cases of exposed area. They are readily obtained from the previous columns by making allowance for the horse-power necessary to haul that part of every ton, total weight, which must go into motive power, machinery, and fuel. Columns 54 to 62 inclusive show the ratios between horse-power required by the two agents for hauling a ton of *load* (freight and freight car) at the different speeds, efficiencies, and area relations.

It is plain that if we can now obtain the ratio of cost per horse-power hour, as given by the two agents, in the corresponding cases, we can easily determine the speeds at which the one or the other agent becomes the most economical.

Let us first obtain the cost in electric propulsion.

TABLE I.

Speed.	Tonnage.	Areas exposed per ton in square feet.						Rate of work in H.P., 10 per cent. loss.						H.P. at 20 per cent. loss.			H.P. at 40 per cent. loss.		
		1·0	0·75	0·5	0·25	0·2	0·1												
		Horizontal effort.						2 & 3	2 & 4	2 & 5	2 & 6	2 & 7	2 & 8	2 & 3	2 & 5	2 & 8	2 & 3	2 & 5	2 & 8
20	8	2·6	1·95	1·3	0·65	0·52	0·26	0·61	0·58	0·534	0·501	0·49	0·48	0·70	0·07	0·55	0·93	0·8	0·73
40	8	5·2	3·90	2·6	1·3	1·04	0·52	1·56	1·40	1·23	1·068	1·05	0·99	1·77	1·40	1·12	2·37	1·86	1·5
60	8	7·8	5·85	3·9	1·95	1·56	0·78	2·77	2·43	2·09	1·75	1·67	1·54	3·15	2·37	1·77	4·20	3·2	2·37
80	8	10·4	7·80	5·2	2·6	2·8	1·04	4·32	3·70	3·00	2·46	2·35	2·00	4·90	3·50	2·37	6·53	4·6	3·2
100	12	13·0	9·75	6·5	3·25	2·6	1·3	7·32	6·35	5·40	4·45	4·27	3·90	8·32	6·15	4·42	11·1	8·16	5·9
120	15	15·6	11·70	7·8	3·9	3·12	1·56	10·79	9·39	8·03	6·65	6·32	5·84	12·21	9·12	6·66	16·3	12·2	8·85
140	20	18·2	13·65	9·1	4·55	3·64	1·82	15·67	13·7	11·88	10·06	9·75	8·95	17·80	13·5	10·17	23·6	18·0	13·5
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

Speed.	Tonnage.	Coal and water for one hour. 5lb. coal. 15lb. water.						Locomotive and tender at 100lb. per horse-power.			Weight: machinery and fuel; and load. Steam. 10 per cent.			Weight: load; and weight of machinery. Electric. 10 per cent.			Weight: load; and weight of machinery. Electric. 20 per cent.			Weight: load, and weight of machinery. Electric. 40 per cent.		
		2 & 3	2 & 4	2 & 5	2 & 6	2 & 7	2 & 8	2 & 3	2 & 5	2 & 8	2 & 3	2 & 5	2 & 8	2 & 3	2 & 5	2 & 8	2 & 3	2 & 5	2 & 8	2 & 3	2 & 5	2 & 8
20	8	12·3	11·66	10·65	10·12	9·9	9·6	61·6	58·3	48·4	73 1927	69 1931	57 1943	1964 36·6	1968 32·	1971 28·8	1958 42·	1964 36·	1967 33·	1944 55·8	1952 48	1956 438
40	8	30·8	27·9	24·6	21·30	21·07	19·8	154	139·7	99·0	185 1815	164 1836	119 1881	1906 93·6	1926 73·8	1941 59·4	1894 106·2	1916 84·	1933 67·2	1858 142·2	1888 111·6	1910 90
60	8	55·4	48·6	41·8	35·0	33·4	30·8	277	243	154	332 1668	285 1715	185 1815	1834 166·2	1875 125·4	1908 92·4	1811 189·0	1858 142·2	1892 106·2	1738 262	1808 192·	1858 142·2
80	8	86·2	73·9	61·8	49·3	47·1	42·1	431	370	210	517 1483	432 1568	252 1748	1741 259·2	1820 180	1880 120·	1706 294	1790 210·0	1858 142·2	1608 391·8	1724 276	1808 192
100	12	146·5	131·2	108·2	89·0	84·3	77·8	732	636	389	878 1122	744 1256	477 1523	1561 439·2	1676 324	1766 234	1500 499·2	1631 369	1735 265·2	1334 666	1510 489·6	1646 354
120	15	215·4	187·88	160·	133·0	127·4	116·8	1078	939	584	1293 707	1099 901	701 1299	1354 646·2	1518 481·8	1650 350·4	1268 132·6	1453 547·2	1600 399·6	1022 978	1268 732	1469 531
140	20	313·5	276·0	237·	201·0	195·1	179·1	1567	1380	895	1880 120	1617 383	1074 926	1060 940·2	1287 712·8	1517 483·	932 1068	1190 810	390 610·2	584 1416	920 1080	1190 810
		21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41

Speed.	Tonnage.	Power for one ton, freight and car, steam. 10 per cent.			Power for one ton, freight and car, electric. 10 per cent.			Power for one ton, electric, at 20 per cent.			Power for one ton, electric. 40 per cent. loss.			H.P. steam. / H.P. electric. Loss on both, 10 per cent.			Ditto. Loss steam, 10 per cent. Loss elec., 20 per cent.			Ditto. Loss steam, 10 per cent. Loss elec., 40 per cent.		
		2and 3	2and 5	2and 8	2and 3	2and 5	2and 8	2and 3	2and 5	2and 8	2and 3	2and 5	2and 8	2 & 3	2 & 5	2 & 8	2 & 3	2 & 5	2 & 8	2 & 3	2 & 5	2 & 8
20	8	0·633	0·55	0·49	0·62	0·54	0·48	0·715	0·68	0·56	0·95	0·82	0·75	1·01	1·02	1·02	0·88	0·81	0·87	0·66	0·67	0·65
40	8	1·72	1·34	1·05	1·63	1·27	1·02	1·88	1·46	1·15	2·55	2·0	1·57	1·05	1·05	1·03	0·91	0·92	0·91	0·67	0·67	0·66
60	8	3·32	2·44	1·70	3·02	2·23	1·61	3·48	2·55	1·87	4·8	3·54	2·55	1·1	1·09	1·05	0·95	0·95	0·91	0·69	0·68	0·66
80	8	5·83	3·82	2·28	4·96	3·3	2·13	5·74	3·91	2·55	8·12	5·34	3·54	1·17	1·16	1·07	1·02	0·98	0·90	0·71	0·71	0·65
100	12	13·05	8·60	5·12	9·38	6·44	4·42	11·08	7·54	5·09	16·6	10·8	7·17	1·39	1·33	1·16	1·17	1·14	1·00	0·78	0·8	0·71
120	15	30·4	17·8	9·0	15·9	10·5	7·08	19·25	12·5	8·35	31·8	19·25	12·0	1·91	1·7	1·27	1·58	1·42	1·08	0·95	0·92	0·75
140	20	260·8	62·0	19·3	295·6	18·46	11·8	38·2	22·7	14·63	80·8	39·1	22·7	8·8	3·35	1·64	7·00	2·7	1·39	3·2	1·6	0·85
		42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62

TABLE II.—Elements of the cost of 1 h.p. hour, electric, in cents.

Capacity	100	300	500	800	1,000	1,500	2,000	3,000	4,000	5,000	6,000
Engineer	0·4	0·13	0·08	0·05	0·04	0·04	0·04	0·04	0·04	0·04	0·04
Fireman	0·3	0·10	0·06	0·037	0·03	0·03	0·03	0·03	0·03	0·03	0·03
Dynamo man	0·4	0·13	0·08	0·05	0·04	0·04	0·04	0·04	0·04	0·04	0·04
Helper	0·25	0·08	0·05	0·031	0·025	0·025	0·025	0·025	0·025	0·025	0·025
Superintendence	0·30	0·10	0·06	0·037	0·03	0·02	0·015	0·001	0·001	0·001	0·001
Coal	0·475	0·475	0·475	0·475	0·475	0·475	0·475	0·475	0·475	0·475	0·475
Oil, waste, and water	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15
Interest and depreciation steam plant	0·057	0·051	0·044	0·033	0·028	0·022	0·022	0·022	0·022	0·022	0·022
Ditto, electric plant	0·057	0·051	0·044	0·033	0·028	0·022	0·022	0·022	0·022	0·022	0·022
Ditto, building	0·028	0·026	0·022	0·168	0·014	0·011	0·011	0·011	0·011	0·011	0·011

For this, form Table II., showing the elements in the cost of one horse-power hour in stations of various capacity—from 100 to 3,000 h.p. Engineers and dynamo-men are assumed to receive 40 cents per hour, and to superintend a maximum of 1,000 h.p. This would produce, in some cases, fractional engineers, as for a 1,500-h.p. plant, but such complication has been avoided by assuming a constant value per unit of power, in the pay-roll element in plants exceeding 1,000 h.p. Firemen and helpers are taken at 30 and 25 cents per hour respectively. Superintendence at 30 cents per hour is apparently low, but is equivalent to 60 cents for daylight hours, since the plant is able to run 24 hours with the same general superintendence as for 12 hours. It is further supposed that the total of this item will not require increase until the capacity reaches 3,000 h.p. beyond which it remains constant per unit of power. As no other element of cost is supposed to vary beyond this point, the table shows here a minimum total cost per unit, and a constant cost beyond it.

Coal is assumed to cost 3 00dols. per ton, and to be consumed at the rate of 3·2lb. per electric horse-power hour in the dynamo. A very slight error is made in taking the rate of consumption as constant while changing the capacity of the engines.

Cost of steam plant is taken to vary from 50dols. per horse-power in a small plant to 20dols. in a plant of 1,500 h.p. This latter figure may seem too low to some, but I have recently seen the figures for an 800 h.p. plant in a neighbouring Massachusetts city which cost in place at the rate of 22dols. per horse-power.

(*To be continued.*)

PROF. ELIHU THOMSON'S ELECTROMAGNETIC INDUCTION EXPERIMENTS.*

BY J. A. FLEMING, M.A., D.SC., M.I.E.E.

(*Concluded from page 452*).

In a closed iron circuit embraced at one part by a magnetising coil, and subjected to rapidly-reversed magnetic force, the magnetic induction does not confine itself wholly to the path of least magnetic resistance—viz., the iron path—but takes a short circuit in part across the interior air space. This waste field may in badly-designed transformers be something considerable. I believe that an important point to hold in view in transformer construction is to subject the iron circuit uniformly to the magnetising force by embracing all portions of the iron circuit with primary windings, and not locating the windings simply at one part. There is, then, a tendency to check the production of waste field by the lateral budging-out of the magnetic lines of force from the iron. In Fig. 31 is a diagram illustrating the arrangement of primary and secondary coils most favourable for the production of waste field, and in Fig. 32 the arrangement least favourable for the same.

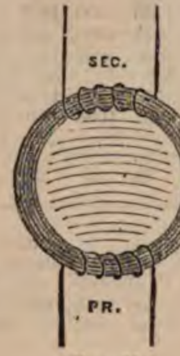

FIG. 31.

The foregoing experiments are of such a nature as obviously to force on us the thought that useful and perhaps important applications can be made in electromagnetic machinery. Prof. Elihu Thomson has, as you can imagine, not been slow to do this; for in him is united both a keen scientific sagacity and that clear mental vision which enables him to pursue to its logical issue in practice the consequences of scientific discovery.

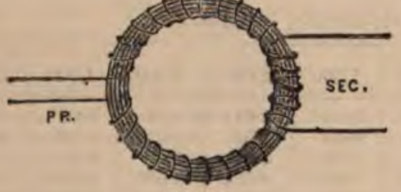

FIG. 32.

He has already applied these principles to the construction of alternating-current indicators, alternating-current arc lamps, regulating devices for alternating currents, and to rotary motors for such currents. For current indicators, a pivoted or suspended copper band or ring, composed of thin washers piled together and insulated from one another, and made to carry a pointer or index, has been placed in the axis of a coil conveying alternating currents whose amount or potential is to be indicated. Gravity or a spring is used to bring the index to the zero of a divided scale, at which time the plane of the copper ring or band makes an angle of, say, 15deg. to 20deg. with the plane of the coil. This angle is increased by deflection, more or less great, according to the current traversing the coil. The instrument can be calibrated for set conditions of use. Time would not permit of a full description of these arrangements as made up to the present.

In arc lamps the magnet for forming the arc can be composed of a closed conductor, a coil for the passage of current, and an iron wire core. The repulsive action upon the closed conductor lifts and regulates the carbons in much the same way that electromagnets do when continuous currents are used. The electro-inductive repulsive action has also been applied to regulating devices for alternating currents, with the details of which I cannot now deal.

For the construction of an alternating-current motor, which can be started from a state of rest, the principle has also been applied, and it may here be remarked that a number of designs of such motors is practicable.

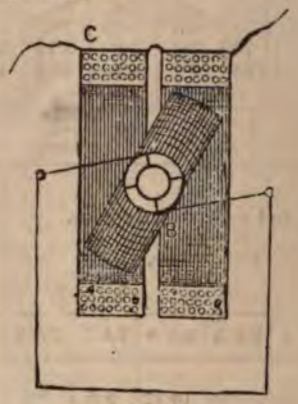

FIG. 33.

One of the simplest is as follows: The coils, C, Fig. 33, are traversed by an alternating current, and are placed over a coil, B, mounted upon a horizontal axis transverse to the axis of the coil C. The terminals of the coil B, which is wound with insulated wire, are carried to a commutator, the brushes being connected by a wire, as indicated. The commutator is so constructed as to keep the coil B on short circuit from the position of coincidence with the plane of C, to the position where the plane of B is at right angles to that of C; and to keep the coil B open-circuited from the right-angled position or thereabouts to the position of parallel or coincident planes. The deflective repulsion exhibited by B will, when its circuit is completed by the commutator and brushes, as described, act to place its plane at right angles to that of C, but being then open-circuited, its momentum carries it to the position just past parallelism, at which moment it is again short-circuited, and so on. It is capable of very rapid rotation, but its energy is small. He has extended the principle to the construction of more complete apparatus. One form has its revolving portion or armature composed of a number of sheet-iron discs, wound as usual with three coils crossing near the shaft. The commutator is arranged to short-circuit each of these coils in succession, and twice in a revolution, and for a period of 90deg. of rotation each. The field coils surround the armature, and there is a laminated iron field structure completing the magnetic circuit."

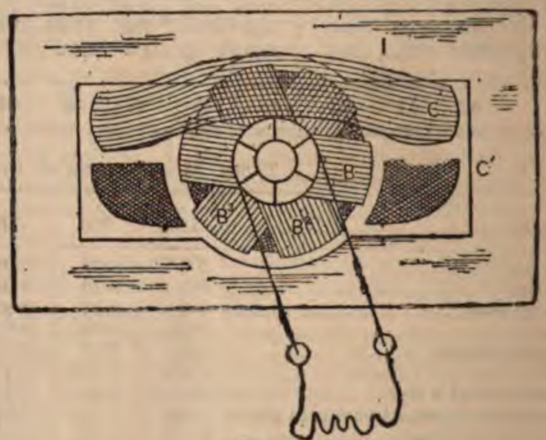

FIG. 34.

In Figs. 34 and 35, we have diagrams which will give an idea of the construction of the motor referred to. C C′ are the field-coils or inducing coils, which alone are put into the actuating alternating circuit. I I is a mass of laminated iron, in the interior of which the armature revolves with its three coils, B, B^2, B^3, wound on a core of sheet-iron discs. The commutator short-circuits the armature-coils in succession in the proper positions to utilise the repulsive effect set up by the currents which are induced in them by the alternations in the field-coils. The motor has no dead point, and will start from a state of rest and give out considerable power, but with what efficiency is not yet known. A curious property of the machine is that at a certain speed, depending on the rapidity of the alternations in the coil C, a continuous current passes from one commutator brush to the other, and it thus performs the function of converting some electric energy from an alternating to a continuous form.

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* Paper read before the Society of Arts, May 14, 1890.

A small motor of a curious type has been made, utilising the principle of "shading" the pole by closed circuits. A laminated ring (Fig. 36) is wound over with wire, but has a slot cut through it, dividing the ring, and causing it to present two pole-faces opposite to each other at the cut part. Each pole is arranged by a set of closed copper bands to be "shaded." A copper disc, free to turn on a shaft, is introduced by one edge into the air gap in the magnet, and turns rapidly when the magnet is excited. A silver coin held just at the edge of the air gap in such an alternating magnet with shaded poles, is drawn into the interpolar space and propelled with some force through the same ; but a lead disc or coin of base metal is not acted upon nearly by the same force owing to its inferior conductivity. I have left myself but little time to speak of numerous applications of these principles in alternating-current meters. The well-known meter of Mr. Schallenberger was described to you here quite recently by Prof. Forbes. There is, however, a new form of meter, designed by Messrs. Wright and Ferranti, which exhibits in a most beautiful manner a practical application of some of these principles which have briefly occupied our attention. In Fig. 37 we have a diagram of this meter. It consists in its latest form of a pair of vertical electromagnets —magnets having divided iron cores. To the poles of these magnets are attached curved horns of divided iron, which lie in a horizontal plane. These curved horns are magnetically throttled at intervals along their length with copper bands. The curved horns embrace a circular space, in which can revolve a light copper or iron shallow cylinder of thin metal. This cylindrical band forms the periphery of a light wheel capable of rotation on a vertical axis. Geared to this axis is a counting mechanism. The axis also carries a vane, having mica blades. The electromagnetic principle may be briefly described thus : The throttling of the curved iron horns causes the rapidly reversed magnetism to take the form of a lateral diffusion of lines of force from the sides of the horns. In effect a series of oppositely-named magnetic poles travels along the horn from the base, where it is in contact with the top of the electromagnet to the tip. These poles are represented by a series of bunches of lines of force setting out laterally from the sides of the horn, and travelling up it. The lateral passage of these lines of force through the metal band which forms the rim of the movable wheel generates in it eddy currents. These are continually repelled by the moving field producing them, and hence a motion of rotation is given to the wheel by the alternating magnetism of the magnetic poles. The speed of rotation, being retarded suitably by the vanes, can be made to be proportional to the current strength of the current exciting the magnets, and hence the total turns of the wheel in a given time to the total electric quantity flowing through the meter. A beautiful adaptation has here been made of the principles we have been briefly studying, and much more might be said in explanation, or rather, in elucidation of the action of this meter did opportunity permit.

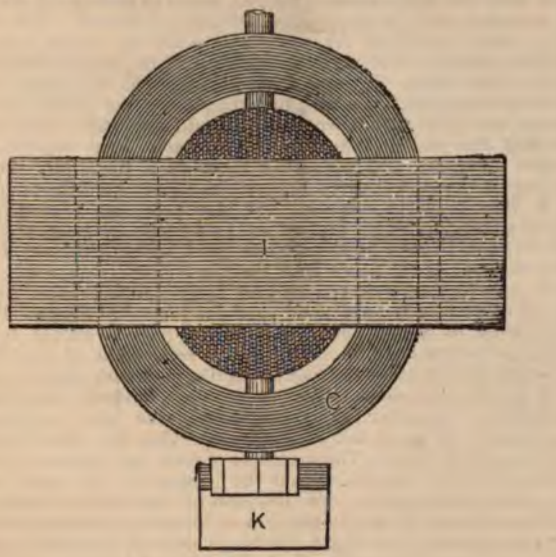

FIG. 35.

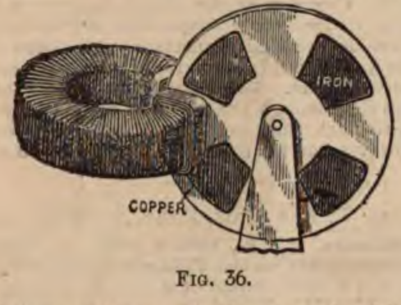

FIG. 36.

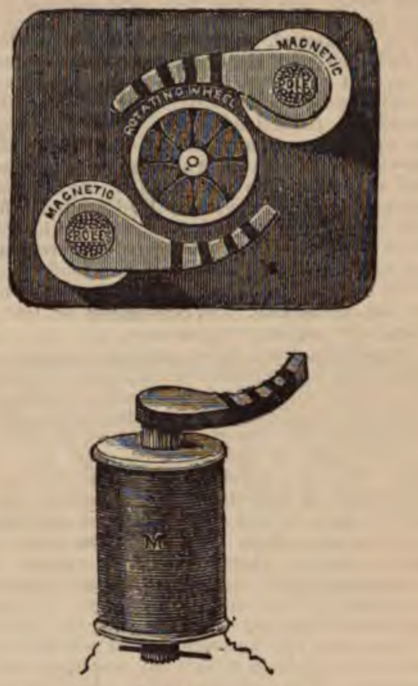

FIG. 37.

It would take me beyond the limits of the time during which I am permitted to trespass upon your attention, if I were to attempt to exhaust the list of electromotor applications that have been made of these electromagnetic repulsions. That is a subject important enough to deserve a separate treatment. In Berlin not long ago I saw a most ingenious form of self-starting alternating-current motor, the invention of Herr von Dolivo Dobrowolsky, in which the rotating portion was merely a solid iron cylinder, constituting a commutatorless armature, revolving in an alternating field, and which acted in a perfectly marvellous manner. The region of practical invention here opened is a very wide one, and I have therefore ventured to direct your thoughts to it to-night, confident that its character in this respect deserves all the attention it can obtain, and that a firm foundation for such work is laid in these interesting researches of Prof. Elihu Thomson.

LEGAL INTELLIGENCE.

CROMPTON AND CO. v. ELIESON ELECTRIC COMPANY, LIMITED.

In this action, which began on Wednesday last before Mr. Baron Huddleston and a special jury, the plaintiffs claimed to recover from the defendants a sum of £450 odd for certain goods supplied and work done for the defendants at their request. It was agreed during the trial that £384 was the amount to be paid the plaintiffs by the defendants. The defendants counter-claimed for damages, urging that in May, 1888, it was agreed between them and the plaintiffs—who at that time knew all about certain arrangements by the defendants with the North Metropolitan Tramways Company—that the plaintiffs should, for reward, undertake and be responsible to the defendants for the superintendence and erection of certain works and buildings, and the running arrangements in connection therewith, and should have the sole control and management of the same, and should exercise all due and reasonable care and skill in such management, and that the plaintiffs undertook to put the whole of the said works, buildings, and plant into proper working order and to do all things necessary to insure the proper working and running of the defendants' traction engines and of the traffic on the North Metropolitan Tramway, so far as it depended upon the said engines, and that the plaintiffs thereupon, in pursuance of the said arrangement, entered upon such management and supervision of the said works, etc., and took possession thereof and assumed their whole control. The defendants alleged that in breach of this arrangement the plaintiffs were guilty of negligence in carrying out the same, and had so caused the defendants serious loss and damage, inasmuch as owing to such negligence the North Metropolitan Tramways Company discontinued the use of the defendants' electrical engines, and refused to continue the arrangements then subsisting between them and the defendants for the employment of such engines, and the defendants accordingly lost the profits and benefits which they would have derived by reason of such arrangements, and the works and buildings which they had erected at Ilford became useless. The plaintiffs denied the agreement as alleged by the defendants, but admitted that in May, 1888, they did agree to take the management of erecting and working the new depot in Romford-road, Ilford, and to engage and pay the men, and in pursuance of such agreement that they did enter upon such undertaking. The plaintiffs denied that at this time they knew of the arrangements between the defendants and the North Metropolitan Tramways Company, as alleged. The plaintiffs further denied their negligence, and also that the defendants had sustained any damage whatever. It appeared that for some six months previous to May, 1888, the date of the agreement between the plaintiffs and the defendants, the defendants had been running their electrical engines upon a portion of the North Metropolitan Tramways Company's system with some success. In August, 1887, it being proposed to extend the use of their engines to other parts of the tramway company's system, the defendants for the time left off running their engines as before, with the intention of enlarging their works, etc., in that connection, and resuming the running again as soon as possible on the more extended basis. With that object the contract in dispute had been entered into by the plaintiffs and the defendants. On September 10, 1888, the running of the defendants' engines was resumed, with the result that one of the engines broke down in the morning, owing, it was alleged by the defendants, to the plaintiffs' negligence in charging the accumulators, and on the same day two other engines broke wheels in going over the tram-line points leading to the defendants' depot. On the following day one of the engines, on being reversed, tore out several teeth in the rack gearing, and was completely disabled. On the following day no mishap occurred, but the defendants on that day received notice from the tramway company to cease running their engines on their system unless they were in a position to take up the entire responsibility of the motive power of their whole tram system. This they were not in a position to do, and the defendants' engines had not since been employed by the tramway company. It appeared that after the agreement between the plaintiffs and the defendants the former took over the management of all the defendants' works and plant in connection with their arrangements with the tramway company. The most important point in the case was, What was the relationship between the plaintiffs and the defendants under their agreement? On the one hand, the plaintiffs asserted that they were merely managers for the defendants in the sense of their foremen, and that consequently they could not be held liable for the negligence of their subordinates, who were really the servants of the defendants. The defendants, on the other hand, contended that under the agreement the plaintiffs contracted to take over the entire control, supervision, and management of all the defendants' works, etc., in connection with the defendants' arrangements with the tramway company, and that this being so, they were liable for all acts of mismanagement by themselves or their servants. It was further urged that where an expert is employed to do work from which special damages are likely to follow, and is aware of all the particular circumstances of the case, he is liable for any such special damages. "Hadley *v.* Baxendale" (9 Ex.), "Boize *v.* Edwards" (*W.N.*, Dec. 28, 1889), and "Simpson *v.* North-Western Railway Company" (3 Q.B.D., 274) were cited in support of this contention. A good deal of evidence was adduced on both sides, and at the close of the case,

Mr. Baron Huddleston, in summing up, told the jury that it had been admitted that the defendants owed the plaintiffs £384, and that therefore for that sum the plaintiffs were entitled to a verdict. The real question arose upon the defendants' counterclaim—viz., were the plaintiffs liable in damages to the defendants, and, if so, to what amount? In considering those questions they would have to decide what was the exact contract entered into between the plaintiffs and the defendants? Were the Cromptons merely managers to the defendants in the sense of a foreman or bailiff's position, or were they really in the position of contractors, taking over the entire management and control of this particular part of the defendants' business, and responsible for the negligence of the defendants' servants as if they were their own? That question really depended upon the view they took of the agreement between the plaintiffs and the defendants in May, 1888. This agreement could not, the learned Baron thought, be said to be in writing. He would, however, leave them to say whether it was in writing or not. If it were, it would be for him to interpret; if not, they would have to say what was the intention of the contracting parties. The second question in the case was that of negligence, which they would have to consider if they found that the plaintiffs were in the position of contractors, as explained, and not merely foremen. The learned Baron then referred the jury to the three heads of alleged negligence and the evidence thereon, and concluded by charging them upon the question of damages, explaining the doctrine of remote damages.

The jury retired to consider their verdict, and, after a considerable absence, they found a verdict for the defendants upon their counter-claim, and that the plaintiffs were contracting parties and guilty of negligence in respect of the accumulators and rack teeth, but not in the respect of the points. They assessed the damages at £184. They also found, as directed, for the plaintiffs on their claim for £384.

Judgment accordingly, and certificate for special jury.

Mr. Moulton, Q.C., and Mr. Graham appeared for the plaintiffs; and Mr. Finlay, Q.C., and Mr. Bousfield were for the defendants.

PHYSICAL SOCIETY.—May 2.

Prof. W. E. AYRTON, President, in the chair.

Mr. C. V. Boys made two communications, first, **"On Photographs of Rapidly-Moving Objects,"** and second, **"On the Oscillating Electric Spark."** A collection of apparatus, by which he had been able to photograph drops of water in their various stages of formation, was exhibited. It consisted of a lantern and lenses, by which a trough in which the drops were formed could be strongly illuminated, combined with a camera and revolving disc with one perforation. By this means exposures of about $\frac{1}{500}$ of a second could be made about 20 times a second. The slide of the camera was about 3ft. long, and could be moved across the field by hand so as to take the consecutive impressions on different parts of the plate. The resulting photographs show with remarkable clearness the formation, breaking away, the oscillations of the drops, and their rebounding in the liquid into which they fall. By cutting the photographs into strips, each strip representing a single exposure, and mounting them on a disc, Mr. Boys had arranged a kind of thaumatrope, which represented the phenomena in a very realistic manner. He also exhibited photographs of small water fountains, broken up into drops by musical sounds, which he had taken by the electric spark without the aid of lenses. The shadows of the drops were sharply defined, even when magnified considerably, and the various stages of transition from the liquid column to the detached particles were well shown. Finding it possible to obtain such good results from a simple spark, it occurred to him that he might get a succession of photographs from the intermittent light of an oscillating spark, and in this he was fairly successful. An apparatus, devised to show the oscillatory character of a discharge, was next exhibited in operation. It consisted of a disc carrying six lenses arranged in two sets of three. The members of each set were at different distances from the axis, so that the images of the spark on the screen do not coincide. The disc can be revolved at a high speed, and the successive sparks are seen as bright patches on the screen. By this apparatus a single discharge can be examined, whereas with Dr. Lodge's apparatus it is desirable to have a fairly rapid succession of sparks. Photographs of an oscillatory discharge taken with the apparatus were exhibited, and these show that the duration of the illumination is a considerable fraction of a complete period. **Lord Rayleigh** said he was greatly interested by Mr. Boys' apparatus. He (Lord Rayleigh) had photographed water fountains, both when broken up and when made to coalesce under electrical influence, but it had never occurred to him that it would be possible to get enough light or sufficient sharpness from a single spark. Mr. Boys' success he believed to be owing to the fact of his using no lenses, which would absorb the ultra-violet rays. He also thought the method might be developed so as to give shaded pictures instead of mere representations in black and white. **Mr. Gregory** asked Mr. Boys if he had tried to get greater potentials for his oscillatory discharges by using Dr. Lodge's "impulsive rush" arrangement. **Mr. Trotter** enquired whether the single sparks used to photograph the water fountains were as large as those required to show oscillations. **Mr. Boys** said he had not tried Dr. Lodge's "impulsive rush" arrangement, because of the enormous capacity of the condensers required. The sparks used to photograph the broken-up fountain was very small, being only about ¼in. long and from a few jars. **Prof. Perry** asked Lord Rayleigh whether it would be possible to compare the shapes of the waterdrops shown in the photographs with the shapes of the liquid surfaces of revolution given by Sir W. Thomson at the Royal Institution some years ago, or whether the changes of shape were too rapid to permit of the surface tension being all important. **Mr. Boys** thought the motions of the drops would be too rapid, and that inertia would play an important part. **Lord Rayleigh** pointed out that by forming a drop slow enough the effect of inertia might be made negligible, until such time as the unstable state was reached; after that, however, inertia must have considerable influence on the shape.

JUNE 6th.—Prof. W. E. AYRTON, F.R.S., President, in the chair.

Mr. H. Tomlinson, F.R.S., read a paper on **"The Effect of Change of Temperature on the Villari Critical Points of Iron."** This, he said, was a continuation of the paper he read before the society on the 21st March, and the methods employed was the same as then described (see *Phil. Mag.*, vol. 28, p. 394). Since then, however, he has made experiments at various temperatures up to 285deg. C., the temperature being determined from the resistance of a platinum wire whose temperature coefficient was carefully determined. The following table shows some of the results obtained with a well-annealed iron wire, 1mm. in diameter, which had been repeatedly heated up 300deg. C., and cooled to the temperature of the room, until the temporary permeability with various loads attained constant values at both temperatures:

Magnetising force in C.G.S. units.	Load in kilogrammes for which permeability is the same as for unloaded wire at temperature.				
	12deg. C.	76deg. C.	167deg. C.	244deg. C.	285deg. C.
2·84	4·7	5·0	5·3 and 12	5·7 and 10	None.
3·70	2·5	3·2	3·6	4·2 & 11·5	4·7 and 9·9
4·8	1·8	2·5	2·7	—	3·1 and 12·3
7·69	None.	None.	None.	None.	None.
10·40	”	”	”	”	”
15·32	”	”	”	”	”

Curves from which the numbers were obtained are given in the paper, and in these load in kilogrammes and percentage change of temporary permeability are plotted. From the curves and table it will be seen that if the first points in which the curves cut the load-line be considered, then at all temperatures the Villari values increase as the load decreases. If, however, the second points be taken, the critical values increase both with load and temperature. In both cases the Villari value is increased by rise of temperature. From the curves it follows that rise of temperature reduces the total variation of permeability producible by loading. A table showing the temporary permeability of the unloaded wire at the various temperatures accompanies the paper.

A paper on "**The Diurnal Variations of the Magnet at Kew**," by W. G. Robson and S. W. J. Smith, was communicated by **Prof. Rucker**. In some preliminary remarks, the Professor pointed out the great advisability of having the results of magnetic observations at various observatories reduced and published in the same manner and for the same periods. In order that this may be effected the methods of reduction must be reliable, but not very elaborate. The Greenwich plan is too laborious to be generally adopted, but the method suggested by Dr. Wild (Rep. Brit. Ass., 1885, p. 78), in which the mean diurnal variation is obtained from measurements on fine quiet days in each month, is feasible. With a view to further testing the reliability of this method, the work described in the paper was undertaken. Mr. Whipple had made a comparison of two methods for the years 1870, 71-72, with the result shown in the following table.

$K_s - K_w = 0{\cdot}7'$ (minutes of arc)
$G - K_s = 1{\cdot}2'$
$G - K_w = 1{\cdot}6'$

where K_s is the mean diurnal range at Kew, as obtained by Sabine's method.
K_w the mean diurnal range at Kew, as obtained by Wild's method.
and G the mean diurnal range at Greenwich, by the Greenwich method.

He also found that the mean hourly differences followed some definite law. The authors undertook the reduction of the Kew observations according to Wild's method for the years 1883, 1886, 1887; the first was chosen as being a year of maximum sun spots.

The results give: 1883, $G - K_w = 1{\cdot}5'$
1886, ditto $1{\cdot}2'$
1887, ditto $1{\cdot}9'$

There is thus a difference of nearly two minutes in the variations at the two places, and this cannot all be accounted for by the method of reduction. Another peculiarity is that the range as calculated by Wild's method is greater by about 0·5′ than that obtained by Greenwich method, although the latter includes days of moderate disturbance. The total range at both places has diminished by about 1·6′ between 1883 and 1887. The paper is accompanied by tables and curves plotted from the differences in the mean hourly readings at Greenwich and Kew for each of the above six years, and a marked similarity exists between all of them. The mean of the six curves differs in no case by more than 0·4′ from the curve for any year. It is thus possible to calculate the Greenwich values from the Kew numbers, and as these latter are published about two years sooner than the former, this fact may be very important. Referring to the reduction of results, Prof. Rücker said that the Stonyhurst observers and Prof. Mascart were willing to adopt Wild's method; Falmouth, he hoped, would follow suit, and Greenwich had been asked to publish their results in both ways. **Mr. Whipple** said that before recording instruments were available, and the numbers were obtained from separate experiments, the labour involved was considerable, and a single large disturbance or magnetic storm might vitiate the results of a whole year's work. Methods were therefore adopted to eliminate these disturbances. Of these, that used by Sabine may be particularly mentioned. Although declination records have now been obtained for a considerable number of years, the cause of the variations still remains unknown. They do not seem to be dependent on temperature, or on astronomical facts. He considered it valuable to obtain magnetic data from different parts of the earth, but comparisons were only possible when all are published on the same plan. This, he hoped, would result from the efforts of Profs. Rücker and Adams. When this is accomplished, the observations on magnetic force will need treatment; this work will be laborious, and the aid of volunteers, like Messrs. Robson and Smith, would be of great service. **Prof. W. G. Adams** said he was glad to see the satisfactory nature of the work which had just been brought before the society. Usually, the mass of figures to be dealt with was so large that the mere reduction was a great undertaking. If, however, the difference between results obtained by the Greenwich and Wild's method was not more than 0·4′, it may be possible to make out the causes of the variations from observations reduced on Wild's plan. He himself would put more faith in horizontal force observations; and, if they wished, they could be worked out by some ready method. He hoped the one adopted in America, of obtaining mean curves by photography, may prove satisfactory. **Prof. Perry** asked if a machine could not be made to do the work. **Mr. Whipple** said such machines had been used by the Meteorological Office, but they were so elaborate and expensive that clerical work was just as cheap. The method of photographing mean curves had been tried at Kew, but it was open to the objection that accidental disturbances, such as those produced by the movement of iron in the vicinity, and the approach of cabs, etc., were not eliminated. **Mr. Boys**, referring to the use of integrators, said that for a harmonic analyser his disc-cylinder pattern was preferable to the ball disc-cylinder integrators of J. Thomson, for it is much cheaper and has less inertia. The **President** said the movement initiated by Prof. Rücker would be of great service if it resulted in the numbers obtained at the various magnetic observatories being published in the same way. It was a great advantage to have such men, who were not permanently attached to an observatory, to take up the subjects and suggest improvements. The heads of such institutions were usually too much employed in making the necessary reductions to have time for devising improved methods. In his opinion, greater freedom should be allowed to the chiefs of observatories, for it should be borne in mind that the object of observations is not to produce volumes of figures but to increase our knowledge. Referring to the reduction of observations, he thought the voluntary services of senior physical students should be more generally accepted, and to this end he suggested that properly recommended persons should be allowed to spend some time in observatories as honorary assistants. This would be of great use to the students themselves and an advantage to the observatories, for the reduction of observations could then be expedited. As regards the accidental disturbances referred to by Mr. Whipple, he contended that regulations should be adopted to render them impossible.

COMPANIES' MEETINGS.

NORTHAMPTON ELECTRIC LIGHT AND POWER COMPANY, LIMITED.

A meeting of the shareholders of this Company was held on Tuesday in last week at the Town Hall, **Mr. S. L. Seckham** (Director) presiding.

The first annual report was submitted as follows: Your Directors have much satisfaction in reporting as to the work accomplished during the first year of the Company's existence. The difficulties connected with the launching of an enterprise of this kind are many and weighty, but by daily and unremitting attention they have been one by one successfully overcome. The first question of importance was to obtain a central site at a reasonable cost. No less than three purchases in Angel-lane have been effected in order to obtain what was required, and after allowing for the sale of part of the frontage to the Corporation for widening the street, the net cost will be £810, a very reasonable price, amply justifying the long and troublesome negotiations which led up to this result. In the next place it became necessary to obtain such sanction to the Company's operations as would admit of work being commenced at an early period. With this view application was made to the Board of Trade for a license which would give the Company a tenure of seven years. The Town Council and two local authorities acceded with practical unanimity to the proposals of the Company, and after the formalities imposed by Parliament had been complied with, the license was finally sealed in March last. This mode of authorisation, though sufficient for commencing operations, does not afford adequate security for capital invested, and bearing this in view, and also having regard to anticipated competition, it was resolved to lose no time in applying to the Board of Trade for a provisional order to be confirmed by Parliament during the present session. The procedure in this case is even more difficult and protracted than in reference to a license, but the consents of the three authorities before mentioned were obtained after many questions and doubts had been finally set at rest. Much negotiation has taken place with the Board of Trade in reference to clauses and other details, and ultimately the order has been reprinted in its revised form, with every prospect of being included in an Act before the end of the session. The area proposed has a radius of about two miles from the Town Hall (being practically the same as the area covered by the license)—the district of the Hardingstone Local Board (St. James's-end, Cotton-end, and Far Cotton) being excluded at the instance of that body. Although the action of that Board is to regretted, it in no way affects the success or working of the Company. The provisional order, if and when confirmed, will have an unlimited duration, but subject to a statutory power given to the local authorities to purchase the undertaking on fair terms at the end of 42 years. One result of the prompt action on the part of this Company was to occasion the withdrawal of three rival schemes for which the preliminary notices have been given. The erection of the necessary generating station and plant in Angel-lane has engaged the most careful attention of your Directors. Plans have been prepared by Mr. M. H. Holding, A.R.I.B.A., in conjunction with the consulting engineers, Messrs. Crompton and Co., Limited; and six of the leading contractors of Northampton were invited to send in tenders, with the result that the lowest tender—that of Messrs. Green Bros., at £1,477—was accepted. This part of the work is now proceeding, and will be carried out with all despatch. Engines, dynamos, and other plant have been ordered, at a cost of £5,000, and these will be ready for delivery as soon as the buildings are sufficiently advanced. The same contractors were invited to tender for the first portion of culverts for carrying the electric mains. Five of them responded; and in this case also Messrs. Green Brothers' tender, being the lowest, was accepted, and the culvert in the Drapery has been already commenced. The other streets proposed to be immediately supplied with distributing mains are Angel-lane, Bridge-street (upper part), George-row, St. Giles's-square, Mercers-row, Parade, Newland (part), and Prince's-street, (part). The capital at present ubscribed will be, so far, sufficient, but additional capital will be required when it is found desirable to extend the works. The first portion of the general scheme in relation to buildings, machinery, and mains has been conceived not only with a view to immediate requirements, but with due regard to future and extensive development. It is confidently believed that the foundation has thus been laid for a large and successful enterprise. From various quarters promises are being received to make use of the electric current, and if these assurances are realised it will only remain to increase the capital and extend the operations of the Company in order to secure its ultimate success. Your Directors believe that the undertaking will not only prove remunerative, but be a great boon to the inhabitants of the district. It will be seen by the foregoing statement that the time has arrived for calling up the remainder of the subscribed capital in order to provide the necessary funds for carrying out the work. Two of the Directors, Mr. D. J. Morgan and Mr. F. H. Thornton, retire by rotation, but offer themselves for re-election.

The **Chairman** proposed the acceptance and adoption of the report and statement of accounts read by the Secretary, which latter showed: To share capital, 10,000 shares of £1 each, £10,000; to amount paid on 10,000 shares, £4,850; interest in Union Bank, £14. 7s. 6d.; total, £4,864. 7s. 6d.; by 10s. per share paid on application and allotment on 9,500 shares, £4,750; on account of 500 shares, £100—£4,850; remaining unpaid on account of 500 shares, £150; by 10s. per share to be called up on the whole 10,000 shares, £5,000—£5,150; altogether, £10,000; by purchase of land in Angel-lane, £920; by land tax redemption, £6. 19s. 7d.; by interest on purchase-money, £3. 2s.; by Board of Trade deposit (to be returned), £1,000; by solicitors' charges on account of formation of company, license, etc., £300; registration fees and stamp duties, £67. 5s.; by Board of Trade license, £50; by Board of Trade provisional order, £50; by sundry accounts for advertising, printing, stationery, etc., £158. 5s. 5d.; brokerage, £110. 16s.; £736. 6s. 5d.; balance at Union Bank, £2,197. 19s. 6d.; total, £4,862. 7s. 6d. The report and accounts were adopted.

On the proposition of the **Chairman**, Messrs. D. J. Morgan and F. H. Thornton, the retiring Directors, were re-elected.

Mr. S. Hull was appointed auditor, the duties of which office he filled on the request of the Directors last year.

NEW COMPANIES REGISTERED.

Bishop's Stortford Electric Light and Steam Laundry Company, Limited.—Registered by Acklands and Nockholds, Bishop's Stortford, with a capital of £10,000 in £1 shares. Object: to carry on the business of electric lighting at Bishop's Stortford. Registered without articles of association.

Column Printing Telegraph Company, Limited.—This Company is formed, with a capital of £100,000 in £1 shares, for the purpose of acquiring and working a business founded on Messrs. Moore and Wright's patents for printing, by electric telegraph, political and general news, stock lists, racing results, despatches, and bulletins of all kinds. The special feature of the invention is that the news is printed, not in long, narrow strips, as in the case of existing telegraphic machines, but in regular column form on ordinary sheets of paper. The Company will acquire Messrs. Moore and Wright's patents for £20,000 in cash and £10,000 in fully-paid shares. It is proposed to issue at present 50,000 shares, including the 10,000 to the vendor.

PROVISIONAL PATENTS, 1890.

JUNE 2.

8495. **Reducing speed of or stopping railway trains by magneto electricity, automatically or otherwise, and utilising the electricity by storage in accumulators for lighting or other electrical purposes.** Philip Henry Williams, Egham, Surrey.

8528. **Improvements in devices for transmitting power, and especially for transmitting power from electric motors used for the propulsion of vehicles.** Benjamin Joseph Barnard Mills, 23, Southampton-buildings, London. (Edward Hibberd Johnson, United States.)

8534. **Improvements in secondary batteries or electrical accumulators.** Nicholas de Benardos and Lloyd and Lloyd, 24, Southampton-buildings, London.

JUNE 3.

8559. **An improved electric wall plug or socket for connecting electric wires.** William Rixom, 1, Merthyr-terrace, Castlenau, Barnes.

8567. **Improvements in or relating to conductors and conduits.** Henry B. Cobb, 323, High Holborn, London. (Complete specification.)

8578. **Improvements in electric accumulators or secondary batteries, and in the manufacture and production of plates or elements therefor.** James Yate Johnson, 47, Lincoln's-inn-fields, London. (Carl Hering, France.) (Complete specification.)

8599. **Improvements in apparatus for the generation, distribution, and commutation of electric currents.** Frank Anderson, 45, Southampton-buildings, London.

JUNE 4.

8651. **Improvements in casing for electrical conductors, cables, or the like.** Thomas Smith, 88, Queen Victoria-street, London.

8652. **Improvements in and connected with magneto telephone systems.** Elias Mushback Greene, 55, Chancery-lane, London. (Complete specification.)

JUNE 5.

8703. **Improvements in electric welding.** William Phillips Thompson, 6, Lord-street, Liverpool. (Charles L. Coffin, United States.) (Complete specification.)

8720. **Electro-magnetic brake for railways for reducing high speeds.** Henry Edmond Walter, 24, Southampton-buildings, London.

8730. **Electric soldering irons.** William M. Miner, 97, Newgate-street, London. (Complete specification.)

JUNE 6.

8749. **An "inconsumable candle" for electric light to be adopted to "arc lamps" now existing where carbon candles are in use.** Louis Héndlé and George T. Poole, 12, Phœbe-terrace, Pevensey-road, Forest Gate.

8754. **Improved apparatus for protecting electric conductors from damage by lightning.** Thomas Alexander Garrett and William Lucas, 128, Clerkenwell-road, London.

8758. **Improvements in electric generators.** Raffaele Colacchi and Nestor Rolland, 433, Strand, London.

8777. **Improvements in and relating to electric call-bells.** Henry Harris Lake, 45, Southampton-buildings, London. (Philip Hathaway, United States.) (Complete specification.)

8778. **Electric motors.** Henry Groswith, 1, Queen Victoria street, London. (Complete specification.)

8787. **Improvements in motors and dynamos.** Alexander Schanschieff, 24, Southampton-buildings, London.

JUNE 7.

8853. **Improved combined brake and circuit making and braking device for use with electric motors.** Albert Piat, 46, Lincoln's-inn-fields, London.

8854. **Improvements in and relating to apparatus for measuring electrical energy.** Lucien Alfred Wilhelmine Desruelles and Raphael Fenelon Odile Chauvin, 45, Southampton-buildings, London.

SPECIFICATIONS PUBLISHED

1889.

10082. **Electric switches, &c.** Binswanger. 8d.
11046. **Electrical cores.** Thompson (The Westinghouse Electric Company). 8d.
11296. **Electric incandescent lamps.** Ryder and Dopson. 8d.
11426. **Electric motors.** Newton (Main). 1s. 6d.
11589. **Electric conductors, &c.** Crompton. 8d.
18355. **Secondary generators.** Gibbs and Fesquet. 8d.

1890.

2957. **Electric counters.** Aubert. 6d.
2963. **Electric railways, &c.** Sayer. 1s. 6d.
5645. **Electric railway apparatus.** Odell. 8d.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The receipts for the week ended June 6 amounted to £4,094.

Great Northern Telegraph Company.—The receipts for May were £24,000, making from January 1 a total of £105,800.

Cuba Submarine Telegraph Company.—The estimated receipts for May were £3,400, against £3,513. The receipts for February, estimated at £3,300, realised £3,391.

Western and Brazilian Telegraph Company, Limited.—The receipts for the week ended June 6, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,143.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Anglo-American Brush	—	2¾
— Pref.	—	2⅛
India Rubber, Gutta Percha & Telegraph Co.	10	20
House-to-House	4½	5
Metropolitan Electric Supply	—	5¾
London Electric Supply	5	2½
Swan United	3½	5½
Crompton & Co., Pref.	—	5½
National Telephone	5	5¼
Electric Construction	10	10

NOTES.

Mainz.—The theatre of Mainz is to be lighted by electricity next year.

Gorlitz.—A grant of £30,000 has been made for an electric central station for the town of Gorlitz, Silesia.

Electric Locomotive.—Messrs. Kerr, Stuart, and Co., of Bucklersbury, are building a locomotive for Messrs. Immisch, to be fitted up as an electric locomotive for a light railway.

Electric Railroads in Mexico.—The first electric motor car that ever entered the Mexican republic rolled over the Rio Grande Bridge at Laredo, Tex., the other day.

Alsace.—The town of Sehirmeck, in Alsace, has invited tenders for a central electric lighting station, but so many tenders of such variation have been received that no decision has been arrived at.

Award at New Zealand.—The Woodhouse and Rawson United Company have received a first award of merit for their show of electrical apparatus at the exhibition at Dunedin, New Zealand.

Society of Arts Medal.—The council of the Society of Arts have awarded the society's silver medal to Dr. J. A. Fleming for his paper on "Prof. Elihu Thomson's Electromagnetic Induction Experiments."

Overhead Wires.—A Select Committee of the House of Commons, presided over by Sir Joseph Bailey, last Friday passed the Bill promoted by the London County Council for regulating the control of overhead wires.

Westinghouse and Pullman.—The stock of the Westinghouse Electric Company is to be increased from 5,000,000dols. to 8,000,000dols. George H. Pullman is to take the entire issue of 3,000,000dols. at par, or 50dols. a share.

Journal.—We have received No. 87 of the *Journal* of the Institution of Electrical Engineers, containing the article on "Signalling across Rivers in India," by W. F. Melhuish; and Dr. Oliver Lodge's paper "On Lightning-Guards," with discussion thereon.

Column Printing Telegraph.—Last week the Exchange Telegraph Company made an attack upon the new Column Printing Telegraph Company. The latter have taken up the matter, and now challenge the Exchange Company to a practical and exhaustive test of the rival machines.

Halifax and Bermudas Cables.—The s.s. "Westmeath," with the Halifax and Bermudas cable on board, arrived off Bermuda on the 7th inst., and, having completed the necessary soundings, proceeded to Halifax, which port she reached on the 16th inst., and will at once commence to lay the cable.

The Electric Light for Divers.—Electric lighting has been found very useful in diving operations connected with sunken vessels. The wires are run directly from the poles of the dynamo and are wound around the air-tube, sufficient slack being left for handling the lamp without choking off the air supply.

Tittmaning.—The 2,000 inhabitants of the little town of Tittmanning, in Bavaria, have set their souls on having their streets and houses lighted by electricity. A small central station is now being erected, driven by a turbine from a waterfall of 45ft. head, and the plant is expected to be running in a month or two.

Physical Society.—Papers will be read to-day, Friday, at 5 p.m., before the Physical Society at the Science Schools, South Kensington, by Messrs. C. V. Boys, A. E. Briscoe, and W. Watson, on "The Measurement of Electromagnetic Radiation"; by Dr. Gladstone and Mr. W. Hibbert, entitled "Notes on Secondary Batteries."

Model Tramways.—A good model of the electric tramcars, both by storage cars and by direct conductors, exhibited for some time in the business parts of the City, might be made a considerable help in getting busy City financiers, as well as home and foreign traffic managers, to appreciate the advantages of electric traction.

Dry Batteries.—A new species of so-called dry battery has been devised by M. E. Meylan, who uses a kind of sawdust composed of a special extract from the cocoanut he terms "cofferdam." This is steeped in the exciting fluid, which it absorbs in great quantity, and with such avidity that it is difficult to drive it all out again even under pressure.

Rochester.—The provisional order for Rochester has been issued by the Board of Trade, with a view to the same being included in a confirmation Bill, about to be introduced into Parliament, to the Chatham, Rochester, and District Electric Lighting Company, authorising them to supply electrical energy for public and private lighting and motive purposes within the city of Rochester.

Cuttriss Motors.—Owing to increasing demand for their motors and dynamos, Messrs. Cuttriss and Co., formerly of 72, New Briggate, Leeds, have found it necessary to move into larger and more convenient works, where they will have facilities for the manufacture of heavier machines than those to which their attention has been chiefly given hitherto. Their new address is Elmwood Electrical Works, Camp-road, Leeds.

American Institute of Electrical Engineers.—We are notified that, in accordance with an agreement between the American Society of Mechanical Engineers and the American Institute of Electrical Engineers, the head-quarters of the institute, from the beginning of June, will be at the house of the Mechanical Engineers, 12, West 31st-street, near Fifth-avenue, New York. Communications should be addressed accordingly.

Hamburg.—In the Hamburg central station it has been found that of the four steam-engines two have become defective—one being of 150 h.p. and the other of 400 h.p.—soon after the time of trial running had expired. A law suit is now pending, as the management of the central station refuses to pay the remainder—two thousand pounds. While the engines remain defective the lighting of a portion of the town has to remain in abeyance.

Fan Outfits.—American electric supply companies are now making rather a specialty of ventilating fan outfits for the summer season, comprising a small portable battery and motor, with fan on the armature spindle. Electric suppliers who send to India and the South of Africa, as well as the warmer continental parts, might very well make a point of supplying complete outfits of this kind for use where town circuits are not at hand.

A New Use for an Incandescent Light.—By means of portable incandescent lamps, operated by pocket storage batteries, a New York newspaper has just succeeded in exposing a bogus spiritualist. When the medium impersonating a departed spirit appeared, the electric light held by a reporter was flashed, and the whole *séance* exposed. This incident suggests the possibilities of the portable storage battery in detective work.

Conversazione.—We understand that the president of the Institution of Electrical Engineers, being desirous of rendering the annual conversazione especially attractive, hoped to have been able to hold it in a new *locale*. Every preparation had been made in anticipation of that arrangement, which has, however, unfortunately fallen through, and as it is now too late in the season to make any other, the soirée will be postponed until after the recess.

Reynier Accumulators.—M. Reynier has recently exhibited some new accumulators invented by him, which he calls elastic accumulators. The plates, prepared in special manner, are corrugated and placed one against the other, separated by a padding of silica. The elements are placed in elastic receptacles, which are all compressed together. Further details are promised of this accumulator, the gross weight of which is stated as very small for the output.

Telegraphs to Australia.—In answer to a question as to negotiations for duplicating communication to Australia *viâ* the African system and Mauritius, it was stated in the House of Commons that there were no such negotiations pending, though the Government would be glad to see such a line of telegraphic communication established. We may safely say that experts would prefer the Pacific scheme to the one shadowed out in this question and answer.

Electric Light at Agra.—There is every hope, according to the *Indian Engineer*, that within the space of two months the Taj will be permanently lit up with the electric light. It is proposed to place 1,200-c.p. lights on each of the front minarets, and 1,000-c.p. lights on each of the back minarets and on the Musjid and Jawab. The main building will have no light stationed upon it, and so will be magnificently thrown into relief. The expense has been computed at 12,000 reals.

Mix and Genest.—The International Electric Company, acting as the sole depôt of Mix and Genest, Limited, of Berlin, have opened a branch establishment and showrooms at 34, Aldermanbury, E.C., where the manufactures of this company will be kept in stock. Their works at Bow are fitted with the most modern and improved appliances, and suited to meet all requirements of an urgent and immediate character, thus saving time, and rendering it no longer necessary to communicate with the works at Berlin.

Dortmund.—For some time projects have been considered for the establishment of a central station at Dortmund. It has now been decided to begin operations on a small scale to test the public demand, and a small central station will be erected at once, both for supply of electric light and for the running of electric motors. For this purpose an exhibition has been organised at the town's gas works of electric lamps, motors, etc., the apparatus being supplied by the Deutsche Elektricitäts Gesellschaft of Berlin.

The Fire-Engine of the Future.—Says a Boston (U.S.) fire commissioner: "The question of getting an engine of the greatest water-throwing capacity to the fire with the greatest celerity will, it seems to me, be solved by electricity. Substitute for the steam power of any modern engine, stored electricity, or electric power conveyed to each hydrant, making of your engine a pump on wheels, and you have lightness itself as regards weight, with almost unlimited power of throwing water. This will be the fire-engine of the future."

American Finance.—The finance company known as the Oregon and Transcontinental will be reorganised under the name of the North American Company, with a capital of 50,000,000dols., of which 40,000,000dols., corresponding with the outstanding issue of the Oregon and Transcontinental, will now be issued. The new company will operate in the financing of railroads and the promotion of electric light enterprises, and will be in close affiliation with the Edison General Electric Light and the Thomson-Houston Electric Companies.

Electric Drawbridge.—An iron drawbridge over the Christiana river, at Wilmington, Delaware, is to be worked by electricity. The draw is 250ft. long and 34ft. wide, with a roadway and two footways. The total weight is about 200 tons. The motor is furnished by the Thomson-Houston Company, and at a recent test turned the draw completely around in one and a half minutes. The bridge is lighted with 14 incandescent lights from the same current that supplies the motor. The total cost, including the motor, was 65,000 dols.

An Electrical Testing Station.—An electro-technical testing station for North Germany has just been established at Magdeburg, on the lines of the similar institution at Munich. Experiments and tests for public officials and private individuals will be there conducted, to enable them to gain a clear idea of the cost and practicability of electrical undertakings, and the opportunity will be afforded to electrical works to have their machines, apparatus, etc., tested. A well-known electrician—Dr. M. Krieg, editor of the *Elektrotechnisches Echo*—is chief of the station.

North Sea Cables.—The Great Northern Telegraph Company is contemplating laying down one or two new telegraph cables between Scandinavia and England. A cable will be laid between Gothenburg, on the Swedish side of the North Sea, and Newcastle-on-Tyne on the other side. This will be the first direct cable between Sweden and England. This new cable is expected to bring about a material increase in the Swedish telegraphic intercourse, as a large number of telegrams are likely to be sent by the new line from Russia and Northern Asia to England.

Ibstock Colliery.—An installation of electric light for use both underground and on the surface has been introduced at the Ibstock Colliery. The installation, which was put down by Messrs. Roper, of Bradford, comprises a 300-light compound shunt machine, driven by a 12in. horizontal single-cylindered steam-engine of 2½ft. stroke at 850 revolutions. On the surface the circuit serves two of the large lamps of 4,000 candle-power, which entirely illuminates the vicinity of the pit top, and another circuit serving two more lamps of the same power for illuminating the screens.

Dusseldorf.—A central electric station proposed for the town of Düsseldorf was to have had a capacity of 10,500 lamps of 16 c.p.; but owing to the demand it is decided to enlarge the scheme to a capacity of 18,000 lamps, and new tenders are invited. The works are to be outside the town, on the site of the present gas works. A few of the tenders already sent in are for the alternating system, but most are for continuous current, employing accumulators. All the systems proposed intend supplying the town from one central station, without sub-stations. The committee of selection is presided over by Dr. Kittler, of Darmstadt, and the decision is to be given in the autumn.

Royal Society.—The second ladies' conversazione of the Royal Society was held on Wednesday evening at Burlington House. Amongst the exhibits interesting to electrical folk, Mr. Gambier Bolton, by means of the electric lantern, showed some very fine animal and bird studies, photographed from life; while Prof. J. A. Fleming and Mr. Ernest Thurnauer gave some striking experimental demonstrations of electromagnetic repulsion phenomena. The photographs of lightning exhibited by the Royal Meteorological Society were viewed with a great deal of interest.

Signing a Cheque by Electricity.—One of the marvels of electricity, and one of the most striking of the Edison exhibits, is the little instrument which enables the operator to sign a cheque 100 miles distant. The writing to be transmitted is impressed on soft paper with an ordinary stylus. This is mounted on a cylinder, which, as it revolves, "makes and breaks" the electric current by means of the varying indentations on the paper. At the receiving end of the wire a similar cylinder, moving in accurate synchronism with the other, receives the current on a chemically prepared paper, on which it transcribes the signatures in black letters on a white ground.

Gas v. Electricity in Berlin.—A paragraph in the *Elektrotechnische Echo* states that, notwithstanding the satisfactory running of the public arc lighting in the Kaiser Wilhelmstrasse and the Unter den Linden, the Berlin Municipal Council does not intend to extend the public electric lighting in other important streets. This decision has been come to for the reason that the perfection of gas lighting produced by competition with electric lighting enables them to expect the same result with less cost. The cost for one street gas lamp burning till midnight is about 49s. a year; burning all night the cost is about 96s. a year. The fitting of a street lantern amounts to 100s.

Reduction of Telegraph Rates.—Among the reductions of rates secured by the negotiations at the International Telegraph Conference, which are to come into operation at a date yet to be fixed, are the following: Great Britain to Austria-Hungary and Italy, from 4½d. per word to 3d.; to Switzerland, from 3½d. to 3d.; to Denmark and Norway, from 4d. to 3½d.; to Sweden, from 5d. to 4d.; to Spain, from 4½d. to 4d.; to Portugal, from 5½d. to 4½d.; to Russia, from 6½d. to 5½d. The charge from Great Britain to Germany, Holland, Belgium, and France remains the same; an agreement fixing the present uniform rate of 2d. a word having been entered into in anticipation of the conference.

Short-circuited by a Gilt Edge.—A peculiar accident happened to the East Liverpool (Ohio) Western Electric Company a short time ago that will be of interest to the electrical fraternity. Their switchboard caught fire, machine began "flashing," and lights went out. Upon examination, it was found that an ordinary card photograph had by some means fallen into the switchboard, and the gilt edge around it had come in contact with the two ends of the line, causing a short circuit with the above result. The wires were disconnected from the switchboard, united temporarily with connectors, and everything was started up again, with a stoppage of only a few minutes.

Thomson-Houston Electric Roads.—The Thomson-Houston Electric Company has recently finished the equipment of the following electric tramways in the United States, on which the cars are now regularly running: Georgetown and Tenalleytown Street Railway, five cars and six miles; Vancouver Electric Railway, four cars and three and half miles; Union (N.Y.) Belt Line Railway, 25 cars and 20 miles; Milwaukee Cable Company, 12 cars and 15 miles; Knoxville (Tenn.) Street Railroad, five cars and three and half miles; North Side Railway, Fort Worth, Texas, 15 cars and 15 miles; Attleboro (Vermont) and Wrentham Street Railway, five cars and 6·50 miles; the Albany (N.Y.) Railway, 32 cars and one and half miles.

Royal Meteorological Society.—At the monthly meeting of the society, held last Wednesday, a paper was read "On the Action of Lightning during the Thunderstorms of June 6th and 7th, 1889, at Cranleigh," by Capt. J. P. Maclear, R.N. The author examined a number of trees which had been struck by lightning during the thunderstorms, and found that those which were struck before the rain fell were shattered, while those which were struck after the rain commenced were simply scored, with the bark blown off. It seems that during rain every tree is conducting electricity, and a disruptive discharge takes place where the conductor becomes insufficient. This depends on the position of the cloud, the amount of foliage on the tree, its condition of moisture, and its connection with running water.

The Polarisation of Electrodes.—The maximum polarisation which metallic plates acquire when plunged in an electrolyte varies with the temperature; when silver wires are used the variation is very regular, and tends towards zero as the temperature approaches that of the decomposition of the salt. M. L. Poincaré has investigated this matter by changing the nature of the electrolyte on the one hand and on the other by using electrodes of different metals. With different electrolytes it is stated that the polarisation of the silver is nil at the temperature of decomposition. In substituting wires of gold or iron for those of silver the polarisation has not the same regularity, but the final result is the same. It is therefore concluded from the experiments of M. Poincaré that the polarisation of electrodes is nil at the temperature of the decomposition of the electrolyte.

Distribution of Time.—"Ten years ago," says the *Petit Journal*, "a few pneumatic clocks commenced their service for the first time in Paris. To-day, three arrondissements contain 9,000 of these pneumatic dials. The word *pendules* (clocks) is no longer fashionable. In five years more 10 arrondissements will be canalised, and 30,000 people will have subscribed for dummies." This item is a sign of the times, and should be noted by electricians, for there is nothing absolutely necessary about the system that pneumatic tubes should be used, and electric wires would probably be cheaper and easier and quite as effective. Instead of a real and costly clock in each room of a large building, such as the Law Courts, one good clock with a number of dummy faces worked by a step-by-step action would equally serve, and would save both first cost and continuous attention.

City of London and Southwark Subway Bill.—A Select Committee of the House of Lords, on Tuesday, presided over by Lord Belper, passed the Bill, which has already been sanctioned by the House of Commons, authorising the City of London and Southwark Subway Company to extend their line, now in course of completion, from its present terminus at Stockwell to Clapham Common. The clause for the protection of the National Telephone Company is retained. For the purpose of carrying out this extension of seven furlongs, nine chains, the company are empowered to raise £200,000 additional capital, and to borrow in respect of that capital the sum of £50,000. The name of the company is changed by the Bill into the "City and South of London Railway Company," and an extension of time is granted within which to complete the construction of the original line.

Transmission of Power at Heilbronn.—The Würtemberg Portland Cement Works, at Lauffen-on-the-Neckar, has decided to utilise the large amount of water power at its disposal, in so far as it is not required for the cement factory, in the production of electric currents, which are to be transmitted to the town of Heilbronn, distant about seven miles, to be used for lighting purposes and for working electric motors. In order to supply the electrical current for industrial purposes, it is proposed to reduce the cost of the installation as much as possible by the erection of thin overhead wires. The company has already applied to the State and municipal authorities for power to carry out the undertaking, in order, if possible, to have it ready for the winter. Mr. Oscar von Miller, of Munich, according to a correspondent of *Industries*, has been commissioned to design the details and superintend the execution of the enterprise.

Thermo-Magnetic Apparatus.—The two following pieces of laboratory apparatus have been devised by J. Stefan to exhibit thermo-magnetic phenomena. The first, a thermo-magnetic pendulum, consists of a nickel segment attached to the end of a strip of brass, which is movable round a horizontal axis, and is provided above this axis with a sliding weight. When at rest the nickel segment lies between the poles of a horseshoe magnet. On heating one end of the segment, however, that end immediately moves upwards, and if the heating is continued a regular oscillation may be started. The second piece of apparatus is merely a nickel disc, which can rotate around an axis passing through its centre of gravity. The poles of a horseshoe magnet cover a portion of the rim, and on heating another portion the wheel commences to rotate, and under favourable conditions can be made to revolve at the rate of 60 revolutions a minute.

Trees at Weybridge.—A case of some importance to electrical engineers and of considerable interest to the inhabitants of Weybridge was heard at Chertsey last week Three of the engineers of the electric light company were summoned at the instance of Horace Avory, barrister, for damage to trees by the wires. At an early period, it appeared, difficulty had arisen with the trees, and several poles had been shifted in consequence of the owners giving notice that they would not allow the trees to be cut. The present action arose out of the damage alleged to be done to trees dedicated to the public in the avenue outside Mr. Avory's grounds, and over which he claimed rights. Damage to the amount of 10d. for each tree was claimed. The question was argued on points of law, it being regarded as a test case, important interests being involved. It was maintained that freehold extended to the middle of the road, although the Sovereign and subjects had rights to pass. The case was adjourned.

Electric Excursion.—It is proposed that the members of the Electrical section of the London Chamber of Commerce should have an excursion on the river on Saturday, July 5th. It is intended to engage one or more electric launches, but it is necessary that members who intend to be present should notify the same to Mr. A. P. Trotter, 28, Victoria-street, S.W., that the necessary arrangements for luncheon, etc., may be made. The start will probably be made from Surbiton. Members may bring friends (ladies or gentlemen), but no member can have more than four tickets, including his own. The price of the tickets (not including wine) cannot be definitely settled until it is known how many will be taken, but it will not exceed twelve shillings. The list will close on Monday next, 23rd inst., at 10 a.m., on or before which date it is requested that members intending to join will have signified their intention of being present, and the number of tickets required.

Ozone Room Purifiers.—It has been demonstrated that one of the most beneficial ways of purifying rooms troubled with vitiated atmosphere is by the production of ozone by electrical sparks, and Dr. Richardson has recommended the method for purifying sick-rooms. An ordinary influence machine spreads a delightful freshness and vigour throughout the air after a series of sparks, and we have seen these machines used as purifiers in crowded drawing-rooms with good effect, and for children's nurseries it should be an aid to healthy surroundings, and so might be made a profitable article of supply. In Philadelphia, we notice, a Dr. Otto Fleming is introducing a small electric machine for the production of ozone. The machine is in a compact form, operated by a small battery, and is enclosed in a polished wooden case, the whole small enough to be conveniently carried. It is particularly adapted to purifying the air of a sick-room, and is said to be meeting with an excellent demand for private purposes.

Carbon Conductors.—Carbon seems to be gaining ground as an efficient electrical conductor for moving parts. Not only is it in large use in America for motor brushes, but a new carbon trolley-wheel for electric cars has been introduced by S. H. Short, of Cleveland. The object of the invention is to provide a wheel with a non-oxidisable surface, to run in contact with the wire, and also a trolley which in its action is practically noiseless. These results are accomplished, it is claimed, by making the body of the wheel of carbon. In forming the wheel a carbonaceous mixture of the kind known as "plastic" or "Bunsen" carbon, which is now universally used for the manufacture of pencils for electric arc lights, is used. The wheel is formed in suitable moulds under great pressure, so that the surface becomes very much more dense than the interior, and constitutes in effect a very hard skin, which envelopes the body of the wheel. The inventor claims also that by the use of the carbon wheel sparking is prevented, and the wear on the line conductor lessened to a considerable extent.

Telephone Extension in Scotland.—Several important additions have been made to the facilities for telephonic communication in Scotland. Direct communication has been established between Edinburgh and Dundee over a line of 100 miles long. A trunk line has been completed from Edinburgh to Selkirk, Hawick, and Galashiels. Two additional trunk lines have been constructed between Edinburgh and Glasgow, making four lines in all between these two cities. Other and minor extensions have also taken place between Cupar and St. Andrews and between Arbroath and Montrose. To celebrate these extensions, which have been completed almost simultaneously, a number of prominent citizens of Edinburgh were entertained at a service of cake and wine by the National Telephone Company in the Windsor Hotel, Princes-street, on Tuesday afternoon. Mr. A. R. Bennett, the general manager of the company, presided. Telephones in the room connected it both with Dundee and Galashiels, and the visitors had an opportunity of listening to musical performances in both of these towns.

Overhead Wires.—A meeting of the Electrical Trades Section of the London Chamber of Commerce was held on Monday at the offices, Botolph House, Eastcheap, Mr. R. E. Crompton in the chair, when the question of overhead wires was discussed, with reference to the regulations prescribed by the Board of Trade under the provisions of the Electric Lighting Act, 1888, "for the protection of the public safety and of the electric lines and works of the Postmaster-General, and of other electric lines and works." Special reference was made, and objection taken, to clauses 9 and 12 of the regulations, relating to the insulation, etc., of cables and the suspension of conductors; and the chairman expressed his belief that if the requirements of the Board of Trade were enforced they would prove practically prohibitory of work in the future. The question was therefore of universal and supreme importance to the trade. Eventually, on the motion of Major Flood-Page, seconded by Mr. R. S. Erskine, the following resolution was passed: "That this meeting of the Electrical Trades Section of the London Chamber of Commerce, feeling that if the Board of Trade insist upon their decision with regard to cables, as announced in their letter of 30th ult. to Messrs. Crompton and Co., it will be detrimental to the interests of the electrical trade without providing additional protection to the public, earnestly solicits the Board of Trade to give their favourable reconsideration to articles 9 and 12 of the rules and regulations for overhead wires, with a view to their decision being modified."

Increasing Traction by Electricity.—The subject of a possible adhesive action produced between wheel and rail on single trolley roads, says the *Electrical World*, has frequently been alluded to, but in a very unsatisfactory manner. Statements have been plenty, but facts few. In a communication just published Mr. E. E. Ries discusses the general topic from the standpoint of a rather wide experience, and puts the *rationale* of the action very distinctly. He shows from the results of definite experiments that the electric current produces increased adhesion under certain circumstances. The condition for such action is that the current density over the areas of contact shall be great enough to produce strong surface heating even to the point of incipient welding. This naturally occurs with regularity only when the current is a powerful one, stronger than is met with, as a rule, in street railway practice. The welding, or, rather, sticking action is instantaneous, and the subsequent cooling is so rapid that the opposed surfaces are not perceptibly affected. Naturally, the strongest effects are obtained when a powerful current, which need be but of very low voltage, is deliberately passed from wheel to rail. In this case a striking increase in adhesion is manifested. There may be an effect produced by the surface heating analogous to that in the "rocker," well known to students of acoustics, even with a comparatively small amount of current. In the case of street railways it is probable that the currents used are too small perceptibly to increase traction, except, possibly, on a dirty track where there is flashing under the wheels. On the whole, it may be assumed that there is no such action regularly present to a sensible extent, though it may be present often enough to give colour to the popular opinion. As to the value of a current deliberately applied for the purpose of increasing adhesion, something may be judged from the tests reported by Mr. Ries, but the subject is now under experiment on a considerable scale, and future reports will give more extensive data.

The International Telegraph Conference.—The telegraph companies gave a banquet on Monday night to the delegates of the International Conference in the fine hall of the Continental Hotel. The French companies held aloof on the singular plea of the invitations being addressed to the delegates of States. The guests numbered 180. Sir John Pender presided, and was supported by M. and Mme. Jules Roche, Lord and Lady Tweeddale, Sir James Anderson, M. de Lesseps, Sir F. Dillon Bell, Sir E. Vincent, and many telegraphic, literary, and scientific notabilities. In giving "The health of M. Jules Roche, Minister of Commerce," the president said: "I hope it will not be considered unbecoming of me to say a few words in regard to the telegraph companies, representing, as I do, a large body of submarine and other telegraph companies, who are at the present moment playing an important part in bringing the nations of the world into closer and more harmonious communication. We may claim to have promoted progress politically, commercially, and socially. When the history of the last half-century is written, it will be found that telegraphy will occupy an important page in its record. When we take thought of the vast millions of money turned over by the nations of Europe in their relations with countries beyond the seas, and when we bear in mind that these communications and operations are initiated, followed up, and completed by telegram, we can form some idea of the benefit which our telegraph system has conferred on the civilised world. Further, when we see the nations vying with each other in their desire to promote and extend their colonies, and to take their part in the development of the Dark Continent, we recognise that the beneficent effect of telegraphy is reflected not only in the improvement of the nations themselves, but in the development of products and industries for the benefit of the teeming millions of the world. It would seem as if Providence had created this great power to aid the development of the requirements of humanity. The telegraph system is the pioneer of this good work. We have just surrounded Africa with our submarine system, and that continent is now in hourly communication with the more civilised portions of the world. The systems which I have the honour to represent constitute a great network of international communication. Its mission is peace, and to draw closer the unity and friendship of the nations—in fact, to bring peace and goodwill to their peoples. A few figures will demonstrate the great importance of telegraphy. There are 2,000,000 miles of land lines, valued at 1,550,000,000f. The cables belonging to Governments are 13,178 miles long, and are valued at 100,000,000f. The cable companies have 107,000 miles of cable, costing 900,000,000f., and have a total capital of 1,000,000,000f. The gross expenditure on land lines and cables has been over 2,500,000,000f. The cable ships number 36, with a gross tonnage of 53,780. All this has been created during the last 50 years, and most of the submarine cable portion during the last 25 years. The time occupied in sending a message from London to Egypt is 20 minutes; London to Bombay less than an hour; London to China about two hours; London to Australia less than three hours. It is an axiom that countries which require colonies, and desire to keep their place in the race of progress, feel that they must have their colonies connected with the mother country by these submarine cables."

DEPTFORD STATION AND THE FERRANTI MAINS.

Among electrical engineering enterprises at the period of early development of the industry in England, the large central high-tension system at Deptford will remain noticeable, not only on account of the largeness of its conception, but also on account of the remarkable differences of opinion and statements of fact which have arisen about it. Other enterprises may have had periods of brilliant anticipation by their designers and inventors, periods of trial, of success or of failure, but in all of these the electrical profession as a whole was more or less aware of the progress made, the point attained; and the general judgment as to the usefulness and success, for instance, of accumulators for central distribution, of high-tension series lighting and other departures in electrical science, had been definitely arrived at and acknowledged, with more or less partiality or impartiality, by their respective supporters or opposers. But the alternate high-tension system of supply from Deptford has an altogether different atmosphere surrounding it. The enterprise is large and daring; the engineers are naturally averse to making statements of what they intend to do before they have done it; and the present state is one—possibly somewhat due to the reticence of the engineers—of widely varying accounts of what is being or has been done, so much so that rumours and reports have obtained credit on one side that the scheme will not and cannot work, that the mains have broken down entirely, and that the engineers are non-plussed as to what to do, and have abandoned their intention of supply at 10,000 volts. Engineers have been led to believe some such rumours, and have been under the impression, owing to the delay, that they are acknowledged, when counter-statements have appeared showing that the work is satisfactorily progressing; that the mains have not and never have failed; that the work, though not yet finished, gigantic as it is, is going forward in good order and in workmanlike style; and that not only may success be expected, but has already in large part been achieved.

These conflicting and vacillating beliefs are due in great measure to the paucity of data and detail that have been allowed to be published of the great central station, and we propose in this article to give some particulars of the work and progress which we have gathered ourselves from actual inspection on an official visit, and of details and information afforded us by Mr. C. P. Sparks, assistant engineer to the London Electric Supply Corporation, Limited, and these, we think, will give a better basis for judgment, and put our readers and the electrical profession generally in possession of such data as shall enable them to understand the present position of the enterprise.

WORK AT DEPTFORD.

We must first of all remind our readers that the scheme at Deptford comprises two engines of 1,500 h.p. and two engines of 10,000 h.p., driving Ferranti 10,000-volt alternate-current dynamos for transmission of current through mains to London, and transformation there to currents of 2,400 volts, as for some years distributed from the Grosvenor Gallery. Of these engines, one of the 1,500 h.p. engines is erected and has been running since November last year. This is the only engine running at Deptford at present. A second one is already erected, but is not yet used for supply, and two 10,000 h.p. dynamos are in course of construction, and parts of the immense 42ft. flywheels, the 27-ton shaft, and the huge cranks are being turned up in machine tools erected inside the station.

So much is pretty generally known. We propose to give some particulars as to the methods of running and as to the construction of the celebrated Ferranti mains.

The installation in the West-end of London now consists of 38,000 lamps. The greater portion of these, some 33,000, were originally wired and run from the Grosvenor Gallery. At the present moment they are supplied from the combined resources of Deptford and the Grosvenor Gallery. The method of connection varies according to requirements of cleaning or repair to engines, and of the necessities of foggy days; but the arrangements adopted are usually as follows. During the early part of the day, say from five in the morning till an hour before dusk, three, four, or five in the afternoon, the Grosvenor will run alone. At this time the Deptford station then supplies the greater part of the current, both working together. The Grosvenor usually stops at midnight, and then Deptford will supply the whole till five o'clock the next morning. Occasionally Deptford will work from midnight till one or two in the afternoon, the Grosvenor then helping as current is required. Since January this year Deptford has supplied alone the whole necessary current from midnight till five in the morning. This was with the arrangement of cables at 2,400 volts from Deptford, but this arrangement has just lately—about a fortnight ago—been altered as we shall presently describe, and Deptford is now in the position of being able to supply the whole installation if necessary, the idea being now to make Deptford the principal station, and use Grosvenor simply as a reserve or a stand-by.

It may be mentioned that not only do they intend, but the company are absolutely obliged to clear out of the Grosvenor Gallery by the coming autumn. The plant now at the Grosvenor—two engines and two Ferranti 2,400-volt dynamos—will be removed to Deptford about November, and these will be used as reserve plant.

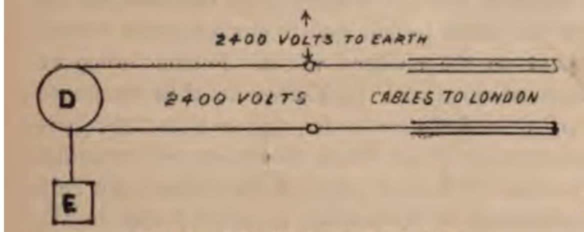

FIG. 1.—Distribution at 2,400 volts.

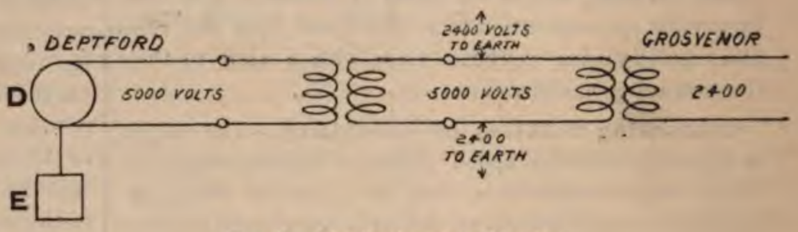

FIG. 2.—Distribution at 5,000 volts.

THE QUESTION OF MAINS.

It will be remembered that the Ferranti concentric mains not being ready, the company laid and run from Deptford to Charing Cross temporary cables of special manufacture. These it was at first hoped would be able to transmit temporarily the 10,000-volt current. Owing to the very large pressure and inexperience in manufacture of insulation for such high tensions, it was soon found that it was impracticable to use the full strength of the current, as the cable failed several times in testing with the full pressure. The dynamos were therefore run with half their exciting current, and the current was transmitted at 5,000 volts. The question of safety to life was raised, and the company, to guard against this, arranged, as our readers know, that one side of the primary should be put to earth. This, on the concentric mains, of course, would mean that the exterior being earthed, no difference of potential (or only a slight one due to loss between Deptford and London) would occur between a man's body and the outer conductor. The inner conductor being, of course, enclosed, no possible connection could be made accidentally with this, except by cutting through the exterior casing and the outer concentric conductor. A trial of such an occurrence lately made, as we have mentioned, showed that the only result would be to break the main fuse at the station. This condition being necessary, the outer conductor of the temporary cable was earthed, making the pressure between the inner conductor and earth 5,000 volts. This was also found to be too much for the temporary cables, and occasional sparking took place through the outer insulation to earth. The pressure was again reduced—pending the construction of the Ferranti concentric cable—of which we shall say more further on—to that of 2,400 or 2,500 volts, the same as that of the Grosvenor dynamos, the inner conductors only of the two cables being used. At this pressure current was transmitted for some time from Deptford to the Grosvenor, where it was used together with the current from the Grosvenor dynamos. The arrangement under these conditions is shown in the diagram, Fig. 1. It is hardly necessary to remark that such an arrangement reduced by half the output that could be transmitted at even the half pressure before used of 5,000 volts, and at this lower pressure the whole lighting of the present installation of 38,000 lamps could not be supplied from Deptford.

An ingenious arrangement was therefore adopted and has been running for some weeks, by which, though the pressure to earth from the cables is only 2,400 volts, yet the total pressure of the current transmitted is 5,000 volts, under which conditions the whole lighting can be and has been done from Deptford, the Grosvenor acting merely as reserve. This arrangement, which will doubtless greatly interest our readers, is shown in diagram in Fig. 2. The Deptford dynamo is run at 5,000 to 6,000 volts, and one pole of the dynamo is put to earth. But instead of transmitting direct to the Grosvenor the current is put through transformers *at Deptford*, transformed and transmitted to London still at 5,000 to 6,000 volts. Now, as will be seen by the diagram, though the total pressure between the mains is 5,000 volts or more, the difference of potential between each of the cables and earth (the insulation being kept the same in both) is exactly what it was before in the case of one only—viz., 2,400 or 2,500 volts. In this manner the danger of sparking to earth is overcome, and double the energy is transmitted.

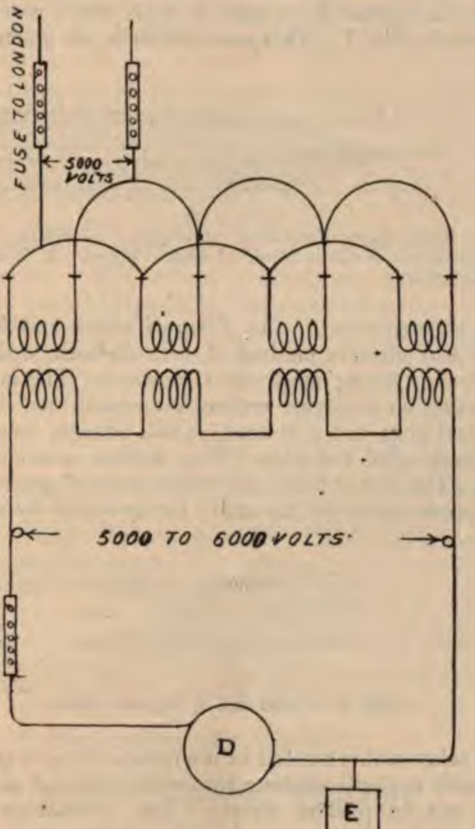

FIG. 3.—Connections of Transformers at Deptford.

The exact arrangement of the transformers is indicated in diagram Fig. 3. Four transformers are arranged with their low-tension coils in series in the dynamo circuit with a high-tension fuse on one pole, and the other dynamo pole being put to earth. On the other side of the four transformers their poles are connected in parallel, passing through two high-tension fuses, and so into the main cables to London. So that each set of four transformers transforms from 5,000 to 5,000 volts, with three fuses in circuit, and one pole on the dynamo side of the transformer being to earth. Three sets as above are arranged at Deptford, each set with its own main switch and three fuses, so arranged that one, two, or three circuits can be thrown in at will, according to requirements at London as intimated by telephone.

These diagrams are reproduced from those kindly given to us by the company's engineers.

Accurate records are kept from day to day and from hour to hour of the current and pressure registered. We have been allowed to inspect these records, full details of which will doubtless be at some time forthcoming, and will prove extremely interesting and useful for electrical engineers. The amounts now registered in daily running show currents of from 30 up to 120 amperes at pressures from 5,000 up to 6,000 volts. This, it will be observed, is already nearly two-thirds the pressure of 10,000 volts ultimately intended to be run. The main laid was originally intended for this higher pressure with a loss in transmission of 8 per cent. The current, as at present sent, is at half or two-thirds only of this, and, of course, the loss in transmission is naturally somewhat higher at the lower pressure. But it is interesting to note that, notwithstanding this extra loss at present, the actual cost of manufacture per unit delivered at London from Deptford is stated by the engineers to be considerably less than the cost of manufacture at the Grosvenor.

MANUFACTURE OF THE FERRANTI MAINS.

We now come to the manufacture of the new Ferranti concentric mains, which are being laid, and will ultimately take the place of the present temporary mains. The details of these mains have been up to the present somewhat shrouded in mystery, and to this fact not a little of that feeling of uneasiness to which we have alluded is no doubt due. We hope to clear up this mystery, and to give reliable particulars such as shall enable electrical engineers to appreciate the simplicity and directness with which Mr. Ferranti has tackled this most important part of his work.

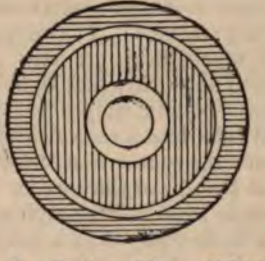

FIG. 4.—Section of Ferranti Main.

We may first state that we have inspected portions of this main now laid or being laid from Deptford to London Bridge. The whole length from Deptford railway station to a point at Crucifix-lane, London Bridge, is now laid and connected, with the exception of some thirty junctions under or along various railway buttresses on the route. This main is being first jointed, in the manner described further on, along the coping-stones of the railway line and then let down and affixed some few feet down on the outside of the railway boundary wall, in a position entirely out of reach of ordinary interference, and yet easily to be got at if necessary by workmen for inspection or testing. The length from the Deptford electric works to the Deptford railway station is now being proceeded with, and is being laid in trenches underground.

From Crucifix-lane it is intended to run to Charing Cross, also underground, as the numerous bends and junctions, owing to the railway bridges, etc., would necessitate a costly arrangement, which will be obviated by running direct under the streets. A difficulty is, however, still to be arranged with the Postmaster-General, who, fearing a possible interference with his telegraph currents, wishes to have an absolute right on his own notification for these mains to be removed if he so judge necessary. Such absolute right over their cables the London Electric Company naturally do not wish to have in force, especially if it can be first proved that no deteriorating interference is experienced. One way or the other, however, connection will be made from London Bridge to Charing Cross, and from here and from the Grosvenor, distribution will be made at the ordinary pressure of 2,400 volts. A main distributing ring will in all probability run round the inner circle of the Underground Railway, from which any point in the company's London district could be supplied.

For the manufacture of the Ferranti concentric mains special machinery has been erected at Deptford, and is now in full working order. Some two miles or so of main are now being turned out every week, and on our visit we were shown the entire process from beginning to end.

The main is of section shown in Fig. 4; first, a small thick hollow tube of copper; then the main insulation; over this the outer hollow conductor of thin copper tube; then another thin coating of insulation; and, lastly, a steel outer casing for prevention of mechanical injury.

The first process is that of insulating the inner conductor. Copper tube of the required section ($\frac{1}{4}$ square inch area) and size is cut off by a circular saw to a length of 20ft. This is taken to a long tressel and long strips of brown paper, 20ft. long and some 4ft. wide, are gummed at one edge to the copper tube. This is now taken to the covering machine. This insulating or covering machine has been specially designed and adopted for the manufacture of these mains, and works with great ease and simplicity.

At one side another machine prepares specially coated paper. This machine is nothing more than a long hot-plate, coke-heated almost to scorching point, over which long strips of brown paper, from huge rolls like that used in printing newspapers, are drawn by rollers. On the hot plate all moisture is driven out, and the strip of paper then passes down, into, and through a hot cauldron of special black oil or wax, coming out soaked in this wax, and is then dried and cut off into 20ft. lengths.

These lengths are carried to the insulating machine first-mentioned, and laid in heaps underneath a long metal table in front of this machine. The copper tube is slowly rotated, and six or seven sheets are then wound on till the inner tube is covered as thickly and tightly as possible.

The next process consists simply in slipping this 20ft. length of insulated tube into a second hollow tube of thin copper, which forms the outer conductor, and which is of corresponding total section to the smaller and thicker inner one. Then the whole is passed through a large draw plate, and the outer tube is carefully drawn down tightly over the insulation.

Next, the insulating process is repeated on the larger conductor—gummed brown paper, inserted sheets of prepared waxed paper, hot wax bath, rolling, and taping.

Finally, the first stage of the manufacture is completed by slipping on the exterior protective casing of thin steel tube. In this steel tube a small hole is drilled in the centre previously, and through this hole hot wax or bitumen is forced in by a force pump, driving out all air at both ends, and forming a compact and solid mass.

JOINT OF THE FERRANTI MAINS.

Next comes the most important and interesting part of the manufacture of the Ferranti mains, the construction of the joints. When we remember that some six or seven miles of this cable are to be laid in each main; that three mains will be laid from Deptford to London at once, and that a joint comes every 20ft., it is evident that the joint is the point at which greatest care must be taken to have perfect insulation and perfect protection against creeping or sparking of the 10,000-volt current.

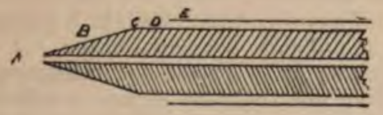

FIG. 5.—One end of Ferranti Main. A Inner Conductor. B Tapered Insulation. C Outer Conductor. D Outer Insulation. E Steel Casing.

The joint is made in the following neat and simple way: *First*, the cable, as manufactured in lengths, is taken to specially adapted turning lathes. There one end of the main is turned carefully and smoothly down in a taper of 6in. length, from the centre conducting tube backwards to the outer conducting tube, as shown in the sketch, Fig. 5. This turning is carefully and accurately done to gauge, and by tools set at the required angle, and is polished off to a smooth surface.

The interior of the inner copper conductor is accurately bored out and smoothed; and then a length, some 18in. or so, of turned solid copper rod is forced into this, a tight metallic fit, as in Fig. 6.

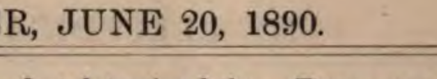

FIG. 6.—With Inner Conductor prolonged. F Solid Copper Bar.

Then a sleeve of thin copper tube, slightly larger than the outer conductor, is slipped over the end of this outer conductor, left bare for several inches for the purpose, and is there corrugated down upon it with three corrugations, as shown in Fig. 7. This corrugation is an essential part of the construction of the Ferranti main, and is a neat, simple, and effective method of securing both good metallic contact and strong mechanical juncture. The method of corrugating on is carried out with a smooth polished steel wheel and grip, and it is used, as will be seen, several times in the making of the joint. This finishes one end of the length. The end is filled up with a piece of greased waste, and capped with a tin cap ready for transport by railway.

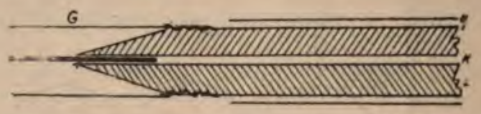

FIG. 7.—With Outer Conductor prolonged. G Sliding Sleeve of Copper Tube. H Outer Steel. I Outer Copper. K Inner Copper. L Insulation.

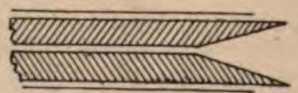

FIG. 8.—Other end of Ferranti Main.

The other end is treated in a corresponding way to form an exactly opposite contour, into which the end of the next length can be pushed tightly. The insulation here is turned out in a hollow coned or taper form from the exterior inwards for the length of 6in., as shown in Fig. 8. This turning is also carefully done with tools set at the required angle and smoothed or polished, and the ends meant to join are tested together to see that they fit.

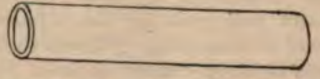

FIG. 9.—Paper Insulating Sleeve.

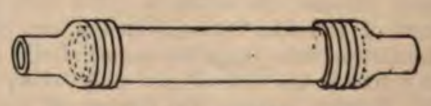

FIG. 10.—Outer Steel Joint Cover.

The main is now ready for actual jointing. In making the joint the ends are pushed together, the solid inner rod, which projects from one end of each length, going into the interior of the inner conductor of the next length. Previously to the jointing, a joint-cover, composed of two pieces, Figs. 9 and 10, is slipped some distance back over the main. This joint-cover comprises a sleeve or tube of waxed paper insulating material, and a length of steel tubing formed like a reducing junction as shown in the figure. To make the joint the ends are pushed together as mentioned, and then are forced together by hydraulic pressure till tight home. The joint is now heated, and the smooth taper surfaces of the joint stick together. After this the copper sleeve, which has now slipped forward over the joint, is corrugated down in the manner before explained upon the other side of the main outer conductor, thus forming metallic connection with this outer conductor. When this is accomplished the paper insulating sleeve, with the exterior steel protecting piece, Fig. 10, are slipped forward over the joint. Hot wax or bitumen is forced in to fill up the space, and finally each end of this steel jointing piece is corrugated down upon the steel protecting tube of the main itself, so forming a compact solid joint.

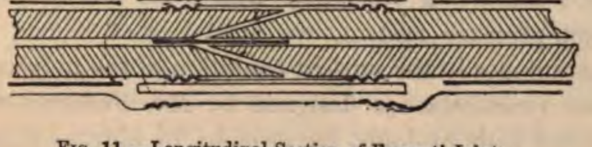

FIG. 11.—Longitudinal Section of Ferranti Joint.

Thus the joints are made. About two-thirds of a mile of this main has been laid and practically tested since April 19. Pressure of 16,000 volts to 18,500 volts have been kept on this length, at intervals as the dynamo has been running, ever since. Since then fresh lengths have been added from time to time, each length being tested as it was put on with 18,500 volts. No breakdown whatever has occurred, even in testing. The actual working current has not actually been passed through at this pressure owing to the evident difficulty of getting rid or absorbing this enormous energy. But this length of main has been tested with 400 amperes of current at a low pressure, and immediately after this test the full testing pressure of 18,000 volts was turned on with equally satisfactory results. One part of the main, where it entered the Deptford works, has been twisted and bent into wavelike form to show that bending can be done without damage to the cable; and also to test this method of allowing for expansion without the necessity for special expansion joints. We shall await with impatience the actual working of these mains to London, but it will be seen that the particulars we have been able to give show great promise of a satisfactory method of dealing with the enormous tensions with which Mr. Ferranti has associated his name at the Deptford central lighting station.

BIRMINGHAM ELECTRIC TRAMWAY.

The electric tramway, with accumulator cars, at Birmingham, upon the Bristol-road route, is now practically in a state of completion. Last week one of the electric cars was run over a portion of the route, and the trial was completely successful. This was a contractor's trial, made for the purpose of testing the gauge, and for mechanical inspection. Eight cars have already been delivered at the Bournbrook depot, and are being fitted up there with the necessary electrical appliances. Four others will shortly be delivered, and it is expected that it will be possible to open the line in another fortnight. Before this can be done, however, the route has to be inspected by a Board of Trade official, and the company will have to satisfy the Public Works Committee of the Birmingham Corporation of the practicability of electricity as a motor. The committee has stipulated that cars shall be run for a month on trial, and they have appointed Mr. Henry Lea to report to them upon their working. The contractor's run last week was so successful, however, that it is believed that much less than a month will be sufficient to convince the company's censors that not only is electricity as a motor practicable, but that electric cars are preferable to any others at present running in the town. There will be 12 cars on the road, and if the traffic requires a five minutes' service will be put on.

The experiments naturally attracted the attention of a very large number of people passing. The car left Bournbrook about half-past eight p.m. It was driven by Mr. T. Parker (of the Elwell-Parker Company), and there were upon it Mr. Edward Pritchard, who with Mr. Kincaid are the engineers to the Central Tramway Company; Mr. Alfred Dickenson, the mechanical engineer; Mr. Henry Lea, and his partner, Mr. W. H. Thornbery, jun.; Mr. A. W. Pritchard, the resident engineer at Bournbrook; Mr. Herring, the traffic manager, and many other officials and workmen. The car contained a full complement of passengers, and it ran along to the corner of Wellington-road without a hitch so far as the electrical appliances were concerned. In turning out of the street leading from the depot to the Bristol-road the wheels of the front bogey ran off the line and a slight delay occurred, and once or twice stops were made to test the brake arrangement, but with these exceptions a good run was made. The net running time from Bournbrook to Wellington-road was about 16 minutes, and along some parts of the road the car travelled over eight miles an hour. The cars, which are constructed to carry 52 passengers, will be lighted by electricity. They will carry 12 sets of batteries, each about 600lb. in weight, and these will be stored underneath the seats and hidden from the view of passengers. At Bournbrook a large depot and charging station has been built, and here the batteries will be charged. A costly plant has been laid down, and by the time the line is ready for opening everything will be in working order. Mr. Alfred Dickenson has invented and Mr. Pritchard has had erected an hydraulic elevator, which will greatly facilitate the work of displacing and replacing the batteries in the cars. A car requiring fresh battery power is run into the shed and between the elevators, which are on either side of the car. The worked-out batteries are drawn on to one of the series of shelves in the elevator, and the elevator is then lowered, and a set of stored batteries on a higher shelf is brought into position and can be pushed into the car without much delay. It is not anticipated that the elevator will be required to be used during the day, as each car will carry sufficient electrical energy to run it for 60 miles, which will be more than a day's work. There are two steam-engines for driving the necessary machinery, but one will be more than sufficient for the whole of the 12 cars, for driving the machinery, for lighting the building, and for providing the effective power necessary for the fitting shop. One of the engines was exhibited at the Paris Exhibition, and was so much liked by Mr. Pritchard that he purchased it for the company. It then drove the machinery for lighting the whole of the exhibition during the 160 days that it was open. The second engine is provided in case of emergency, and indeed nearly all the mechanical arrangements at the charging station are in duplicate. The company will provide their own water supply, and by this means they hope to effect a saving of several hundred pounds a year. The rain water from the roof will be collected in large tanks, and a further supply will be obtained from a well which was discovered when the foundation for the elevator was being dug out. Arrangements have been made for purifying the water, and by passing it through a small quantity of soda-ash all danger of incrustation to the boilers and tubes will be obviated. The two large boilers have been fitted with fuel economisers, which are calculated to save 2·4lb. of fuel per indicated horse-power. No expense has been spared to obtain the most modern and at the same time the most effective machinery. The work at Bournbrook was not commenced until the beginning of December, and the officials have had to work almost day and night since to get the machinery into position. Mr. A. W. Pritchard has superintended the work.

On last Wednesday afternoon the formal inspection by the directors of the Birmingham Central Tramways Company took place. The directors—Messrs. Joseph Smith (chairman), W. Neale, M. J. Smith, and W. J. Carruthers Wain (managing director)—together with Mr. A. W. Pritchard, Mr. A. Dickenson, and Mr. H. Lea boarded the car and rode over the line to the depot, the car being driven by Mr. G. Paulett, of the Electric Construction Corporation, Wolverhampton. This was the first official visit of the directors, and consequently the greatest interest was taken in the movements of the car. The principal anxiety, from a mechanical engineering point of view, was as to the manner in which the car would face what is always difficult in mechanical traction—namely, a sharp curve on a rising gradient. The car, however, glided round the curve in Navigation-street with the utmost ease and to the satisfaction of everybody. A little delay was occasioned on the Bristol-road by a slight defect in the brake, but as soon as this had been adjusted the car was placed under perfect control. On arriving at the depot the party left the car, and the directors were shown over the buildings. They inspected every department, and were considerably interested in the hydraulic elevator which is used to facilitate the work of displacing and replacing the batteries in the cars. At the close of the inspection the directors expressed themselves perfectly satisfied with the arrangements at the depot, and they were also pleased with the success of the trip. All the cars will now be tried in turn in order that the brakes may be properly adjusted, and other mechanical parts tested, and at the end of about a fortnight the company will be ready to carry passengers as soon as they are permitted to do so by the Board of Trade and the Public Works Committee.

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DEPTFORD.

Some of our contemporaries have at various times made merry over our remarks as to the condition and the position of the Deptford installation. We have been publicly and privately challenged to say the work was a failure. Rumours have again and again been circulated to the effect that even hope was lost, and that this part of the scheme and that part of the scheme was irretrievably given up as bad. We have before urged that these rumours in many cases were initiated by ignorance, in others by parties interested in running down the company. Our position in the matter is this: that while from the first admitting no great liking for the alternate high-pressure system, we agreed that it had its advantages in the present condition of the industry; was practicable as designed by Mr. Ferranti, and would without doubt be brought by him to a successful issue. The estimated time when such work as this should be ready to run is generally incorrect; difficulties in detail arise which have to be overcome, but generally outside questions, not thought of in the original conception, influence the time more considerably than anything from within. In the case of electrical work there are legal arrangements to be made with this and that authority, all of which take time. These arrangements in the case of Deptford have been neither few nor unimportant, and are not all settled yet.

On the whole, the industry makes allowances for these difficulties, and is more interested to know that the workers have really met with no insuperable difficulties in carrying out the design. Still, as time passes on, they are anxious to know the exact position of affairs, and it is our aim to give them that information in this issue. From the earliest time that the matter became public we have been in more or less constant communication with the men who are carrying out this gigantic scheme, and have been astonished at the entire and absolute faith they have in bringing it to a success. If we are correctly informed, the Grosvenor Gallery installation will or must stop towards the end of this year, hence Deptford from that time will have to rely entirely upon its own resources. According to the information given elsewhere, we see that even now, if it was thought necessary, Deptford could take over the whole supply. The temporary cables laid are sufficiently good to enable this to be done, with the devised transformation at Deptford. The permanent cables are being as rapidly manufactured and laid as possible, and though the final connections may be delayed by the non-settlement of negotiations with the Post Office authorities, our readers may be assured that the connections will be made at the earliest possible moment. Nothing can be said as to failure or success till the permanent mains are laid and tested by actual work. Many people think that the greatest difficulties must arise in the matter of insulation. It is probably in the insulation that the strains occur, and with alternate currents these strains are under continued reversal. Whether this continuous action will gradually weaken the insulation, and finally break it down, is a question to be decided by time and practice. Even if the insulation is gradually broken down, the question of "how long" is important, as that decides the life of the insulation and one of the charges of maintenance. Insulation which stands a moderately long continued test, or an extremely severe test, may not last long under the continuous strains of permanent work. Here then we venture to predict is the crucial point, which time alone can solve. Those who know the history of submarine cables will know that for a long time men used to talk of ten years as the life of a cable, but experience has shown that the life of a properly constructed and properly laid cable is an unknown quantity, and may be a hundred or a thousand years so far as anyone knows. The same experience may be met with in electric light cables, when they are properly insulated. Many faults developed in the old submarine cables which are not expected in the present day, because of better construction, and so it will be with the electric light cables. However, it is hardly for us to pry into the future, or raise difficulties which are like castles in Spain, shadowy and intangible. The present is what we have to deal with, and the position seems fairly satisfactory. No difficulties worth consideration have been met with in the construction or running of the engines and dynamos. The trouble from the temporary cable has been met by the ingenious device of transforming at Deptford, and the permanent cables are mostly laid—the remainder are being rapidly manufactured and laid. Certain agreements have to be finally arranged, and when this is done we may soon expect to hear that the whole of the Grosvenor Gallery circuits are permanently supplied from Deptford, and that the extended supply is merely a question of days.

While we have all been waiting for Deptford, smaller installations have been projected and carried out in various places; and before another issue the public lighting contract at Bath will commence. This installation is due to the enterprise and energy of Mr. Massingham. The area lighted comprises forty-nine streets, with forty miles of underground cable. The Mayor will switch on the light on the 24th inst., at 9 p.m. This installation, as our readers well know, is a mixed one, both arc and incandescents being provided. The experience Mr. Massingham has gained at Taunton will no doubt have conduced to the success at Bath; and while looking forward to the opening of the largest station in the world, we congratulate the smaller towns in showing their confidence, and in installing a light which from every point of view is superior to any artificial competitor.

CORRESPONDENCE.

LANE FOX ROYALTIES.

To the Editor of the Electrical Engineer.

Sir,—I enclose for your information a copy of a circular which we are about to send round to the owners of private installations on the Lane Fox system. The circular has in the first place been sent to the firms of contractors, and they have been asked to co-operate with us in the collection of royalties from their own clients.—Yours, etc.,

C. A. Stephenson.

2, Princes-mansions, S.W., 16th June, 1890.

The following is a copy of the circular enclosed:

Lane Fox Electrical Company, Limited,
66, Victoria-street, London, S.W.,
June 13th, 1890.

Sir,—I write to inform you that this company is prepared to grant you a license for the use of the Lane Fox system of electrical incandescent light distribution which has been installed on your premises.

The Lane Fox system, which is covered by patent 3,988** of 1878, and others taken out by Mr. Lane Fox during the years 1878 to 1883, is for multiple arc distribution of incandescent lamps; constant pressure being maintained in the conducting mains, and secondary batteries being used as reservoirs of electrical energy.

Our terms for a license for the use of the system are as follows: For every 16-c.p. lamp, fixed—for private houses, 1s. 6d. per lamp per annum; for other installations, such as hotels, clubs, and offices, 2s. 6d. per lamp per annum.

If payment is made for the current half-year by the 30th inst., an indemnity will be granted to you for having used the patents prior to the 31st December, 1889.—Yours faithfully,

C. A. Stephenson, Managing Director.

THE EDINBURGH EXHIBITION.—VII.

Messrs. Cox-Walkers, of Darlington and Edinburgh, exhibit, at stand 103, one of their electric watchman's tell-tales, which they have placed at the service of the Exhibition Committee. It records in ink the movements of the 10 or 12 watchmen patrolling during the night through the exhibition buildings and grounds, the record showing the exact time they visit certain points, and how long they are in going from that point to the next, or how long they remain at any point. The record is marked on a paper fixed to a revolving drum, the whole being kept under lock and key, so that it cannot be tampered with.

They also show the Cox-Walker Swinton patent magneto signal and call bells for colliery and railway work, which dispenses entirely with the use of batteries; magneto telegraph sounders and tappers for military and other purposes where batteries are troublesome; semaphores for shaft and hoist signalling, which are so arranged that no signal can be given to the engineman to start hauling or hoisting until the men at both the top and the bottom of the shaft have signalled that they are ready.

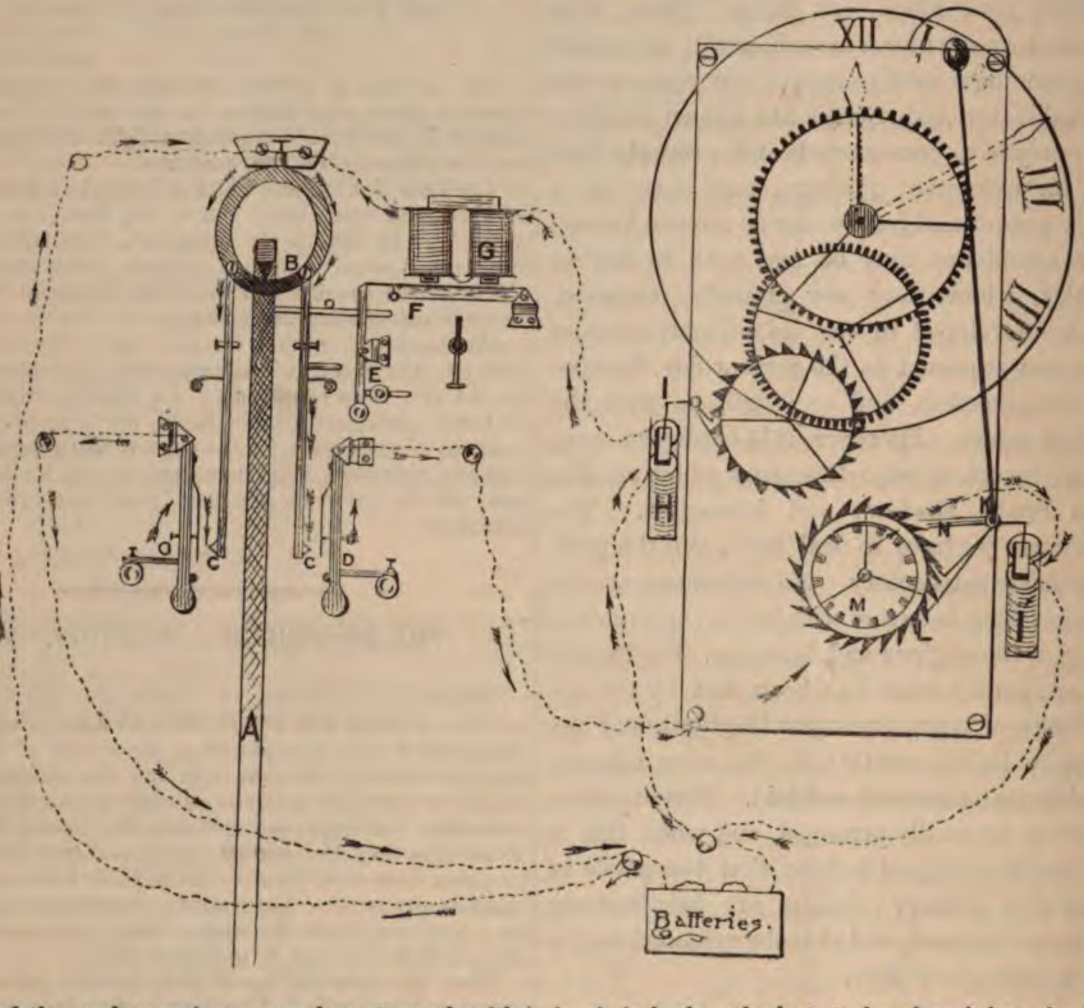
The system of fire alarms adopted for the use of the Edinburgh Exhibition, and carried out by this firm, is so devised that, amongst other things, no indication can be given at the station sending an alarm that its warning has been received unless it is absolutely certain that the bell at the central fire station is also ringing, then the small bell at the alarm-giving station rings in unison with it, and the fact of the small bell ceasing to ring is an indication that the call is having immediate attention. The act of simply breaking the glass and pulling *out* the knob at any one alarm station is sufficient to give an alarm at any number of points deemed necessary. In the case of the exhibition, the pulling out of the knob alarms the whole of the firemen and police stationed throughout the buildings and grounds without in any way tending to create a panic, and at the same time indicates to them the locality of any outbreak of fire, so that no time is lost in reaching the place indicated.

The Electric Date and Time Stamp Company, at stand 40, show some specimens of clocks which close an electric current once every minute. In connection with one of the clocks is an advertising figure, which with the forward movement of the minute wheels rises, displaying a scroll, and bearing the words "Another Minute Gone."

The electric date and time stamp, the invention of Mr. Charles Adams-Randall, is also exhibited. To illustrate the importance of this labour-saving device we may mention that one of them has been in use for over 12 months in the offices of the North Metropolitan Tramway Company for the purpose of recording the time at which the conductors return the way bills, and that from it there is taken daily about 2,000 impressions. The Boy Messengers, Limited, are using the stamp in this way. When a parcel is left to be forwarded the sender receives a voucher stamped with this stamp, whilst a duplicate similarly stamped is affixed to the parcel. The receiver is thus in a position to check the exact time his parcel has been in the hands of the Boy Messengers, and in the event of any suspicion of the time marked on the parcel being tampered with, the voucher of the sender can be appealed to.

The company's system of checking the visits of watchmen to the different points on their rounds will, no doubt, be largely availed of. This system is to lock up, say, in the manager's room one of their instruments and connect it with the several points by conductors. As the watchman passes each point he simply presses a button, and the time at which he does so will be recorded by the stamp. His movements are thus accurately noted down, while he himself has no access to the medium by which it is done.

At stand 41 Messrs. Fairgrieve Bros. show an electrical detached regulator and striking clock combined; the detached pendulum automatically supplying its own driving current, and at the same time transmitting current to one or more sympathetic clock or clocks every two seconds. The clock *or clocks strike* the hours electrically, the motive power for this being also regulated and transmitted by the vibrations of the regulating or primary pendulum. In the accompanying illustration A is the pendulum suspended on a knife edge from the stirrup, B. C C, D D, are contact makers and breakers. The gravity piece and armature, F, falls on the arm, O, and keeps the pendulum vibrating. The gravity piece is released by contact breaker C pressing on the support, E. When contact has been made on the left side the current flows through the magnets, G and H. This lifts the armature and gravity piece, F, and the lever, I, which engages with tooth of wheel, and works the driving train in clock. The circuit for striking is completed every hour through the clock, and when contact has been made on right the current flows through the magnets, J, the armature, lever, and hammer. K is pulled down, the lever engaging with wheel, L, and turning it round a tooth each stroke of the hammer. The hours are divided by insulations between each hour on counter-wheel, M. The circuit is broken the last stroke of each hour by insulation coming under conductor, N.



BRUSSELS CENTRAL ELECTRIC STATION.

OFFICIAL FORM OF TENDER.

(Concluded from page 471).

SCALE OF CHARGES.

CHAPTER I.—*General Conditions of Supply.*

ART. 1. The undertaker furnishes the electric current in the streets in which he has laid his distributing mains, to every consumer who will contract for a period of at least two years, and who will accept the conditions of the present scale of charges.

ART. 2. The householder must procure the consent of the proprietor for the installation of electric apparatus on his premises.

CHAPTER II.—*Branch Mains and Meter.*

ART. 3. The undertaker will run and maintain at his expense the branch mains and accessories from the main conductor up to the meter.

ART. 4. Except under conditions duly authorised by the Corporation, the undertaker will place a meter for the measurement of the electric current supplied to every customer.

ART. 5. The meter will be on hire.

It will be proportioned to the maximum supply of the consumer on the basis of the declaration made in accordance with Art. 12 hereinafter given.

ART. 6. The position of the meter must be convenient from the point of view of the preservation and good working of the apparatus and of the facility of the monthly readings of its indications.

The connections of the meter with the lead and return main, as well as the platform, may be sealed with the seal of the undertaker.

ART. 7. The meter may be tested as often as the administration, the undertaker, or the consumer judge necessary.

If the demand for test has been made by the consumer and the meter is found to be true, the cost of testing must be paid by the consumer, on a scale approved by the Corporation.

ART. 8. The monthly charge for the hire of meter is due at the same time as the price of electric current supplied. By reason of this hire, the fixing, maintenance, and repair of meter are at the undertaker's cost.

ART. 9. The monthly charge for hire of meters is fixed as follows:

Capacity up to		f.		
10 amperes	(or 18 lamps of 16 c.p.)	1.50,	say	1s. 3d.
25 „	45 „	2.25	„	1s. 10½d.
50 „	90 „	3.50	„	2s. 11d.
100 „	180 „	4.50	„	3s. 9d.
200 „	360 „	6.00	„	5s.
300 „	540 „	7.50	„	6s. 3d.

CHAPTER III.—*Interior Distribution.*

ART. 10. The interior installation after the meter will be at the expense of the consumer.

The undertaker may refuse to supply electric current when the interior installation is found to be defective and does not show every guarantee of requisite security and durability.

Except under special arrangement with the undertaker, no lamp connected to the meter may be installed outside the premises personally occupied by the consumer.

ART. 11. The preservation and maintenance of the interior fittings must be carried out by the consumer.

ART. 12. The consumer, when signing the agreement, must indicate exactly the number and kind of lamps he intends to install.

CHAPTER IV.—*Supply of Electricity.*

ART. 13. The electricity will be reckoned as delivered throughout the whole town at one uniform pressure.

The price will be 10 centimes (1d.) per 100 watt-hours.

When all the lamps connected to the same meter have burnt an average of at least 1,000 hours a year, a reduction will be made of 5 per cent. upon the above price.

For 1,200	hours this reduction will be	7½	per cent.
„ 1,500	„	10	„
„ 2,000	„	15	„
„ 2,500	„	20	„
„ 3,000	„	25	„

The average annual number of hours of lighting will be calculated by dividing the number of watt-hours expended per annum as shown by the meter, by the number of watts necessary for the supply of all the lamps on the premises of the consumer lighted simultaneously.

ART. 14. The minimum annual charge for supply of current is fixed at the sum of 7f. 50c. (say 6s. 3d.) per annum per lamp installed.

ART. 15. The sums due for the supply of current and hire of meter are payable every month, and at the house where the electricity has been supplied.

ART. 16. A sum of 5f. per incandescent lamp, and 15f. per arc lamp (with a minimum of 50f.), must be paid to the undertaker before any supply of current, as guarantee.

This sum will be repaid to the consumer at the end of his agreed term.

ART. 17. The payment for supply and hire must be made on presentation of the account, after reading of the consumption, made in the presence of the consumer if he so desire, and marked by the officials of the undertaker in a book, which will remain in the hands of the consumer.

In default of payment within five days the undertaker may refuse to continue the supply of electric current, without prejudice to any of his rights.

CHAPTER V.—*Miscellaneous Clauses.*

ART. 18. In case an accidental circumstance or unforeseen cause oblige the undertaker to interrupt the supply of electricity, he will not be liable to the consumer in any indemnity other than the reimbursement of the price of electric current paid for in advance and not furnished.

ART. 19. The undertaker will have the power, under condition, however, of authority from the Communal Administration, to leave the mains uncharged between the hours of 9 a.m. and 3 p.m., in case of necessity for repairs or inspection of material.

ART. 20. The consumer must at all times allow free access for the officials of the undertaker to the place where the meter is fixed. He must not oppose any work of maintenance or repair of apparatus belonging to the undertaker. He will be held responsible for the preservation of the seals

At certain intervals he must allow the inspection of the interior fittings.

Any opposition to these conditions will render the current liable to be cut off.

ART. 21. The present agreement will be imposed by the consumer upon his heirs and assigns for the term of its duration.

ART. 22. In default of notification from the consumer to the undertaker in writing, two months before the expiration of the agreement, of his intention to discontinue or diminish it, the agreement will continue for another year, and so on year by year unless such a notification be given.

ART. 23. The cost of stamping and registering this present agreement must be paid by the consumer.

The tenders must be sent in, addressed to the Secrétariat de l'Hotel de Ville, Brussels, on or before noon August 1st, 1890, enclosed in envelope, marked on the outside "*Soumission pour Distribution d'Electricité.*"

ELECTRIC LOCOMOTIVES.

In the United States the application of electricity to industrial purposes advances more rapidly than it does in this country. This fact is not the result of want of energy or knowledge among English engineers and electricians. It is a consequence of many factors. Thus, for example, arc lighting makes slow progress here, because, in the first place, gas is comparatively cheap; and in the second, the methods of wiring which pass muster almost without criticism in the cities and towns of the United States, would not be tolerated here. There is, however, an immense propelling force in England which cannot fail to develop electrical science. We refer to the volume of capital seeking remunerative investment. New fields for the utilisation of money are vigorously sought out. Very large sums have already been expended on electric lighting, and the utilisation of electricity as a means of locomotion seems to be only a question of time. The subject is invested with much interest, and presents many problems which demand careful consideration. We propose here to direct attention to a few of them, dealing with them not from the electrician's, but the engineer's point of view.

For the moment it is unnecessary to refer particularly to electrical tramcars. It will be enough to say of these that there appears to be only one feasible way of working them in large English towns or cities, namely, by accumulators. Neither overhead nor underground conductors will at present be tolerated by municipal authorities, who in this respect, and for once, express popular opinion. It is proposed, however, to work the traffic of metropolitan railways by electricity, and if this can be successfully accomplished, it is not improbable that the use of the electric locomotive will be extended. "Metropolitan" is a very elastic word as applied to railways. A great deal of the work of the Metropolitan Railway, for example, is done far out in the country; and if an electric locomotive can manage the traffic between the Mansion House and Bayswater there seems to be no good reason why it should not haul trains to Ealing; and if to Ealing, then Crewe, Bristol, or Carlisle become equally accessible. It will be necessary to prove not only that the work can be done as well by an electrical locomotive as by a steam locomotive, but that it can be done more cheaply. This last is the crucial point. Putting pecuniary questions on one side for the moment, let us see what are the conditions that the electric locomotive must fulfil. Such a locomotive will haul trains by the adhesion of smooth driving wheels to smooth rails, and a moment's thought suffices to show that the electric locomotive which is intended to work metropolitan traffic must be a very different affair from one intended to work tramcars. To begin with, it must be heavy, in order that there may be sufficient adhesion, and we shall under rather than overstate the weight necessary if we put it at 30 tons. We do not think that this could be carried on four wheels. Not, indeed, that the load of 7½ tons on each wheel would be too heavy for the rails, but because it would be difficult to ensure sufficient steadiness. Four-wheeled locomotives have long since become extinct, because four wheels are incompatible with excellence, regarding the locomotive solely as a vehicle. The electric locomotive would be spared some internal disturbing influences as compared with the steam-engine, but not sufficiently, we think, to render four wheels possible save for very slow speeds. The use of three axles, however, presents no difficulty, and may, indeed, prove of benefit rather than the reverse in another way. In nearly all electrical locomotives a motor is mounted on the frames. The armature revolves at a rapid pace, and communicates motion to the driving axles. Now it is apparently a very simple matter to reduce the 800 or 900 revolutions per minute of the armature spindle to the 150 or 200 revolutions per minute of the driving axle. It may be done by belts, pitch chains, wheels and pinions, or screws. All these methods have, however, been tried in the United States, and with results more or less unsatisfactory. One of the most important mechanical problems ever attacked by the inventor is now waiting solution. Belts were abandoned long since; they cannot be trusted under the conditions. Chains were tried, and a certain amount of success has been attained by using chains about ten times as heavy and strong as theory indicated. The simple expedient of putting a pinion on the armature spindle, and a spur wheel on the driving axle, gives most indifferent results. The whole carriage must be fitted with springs, and it is next to impossible to provide means by which the proper distance shall be preserved between the driving axle and the armature spindles, while retaining the requisite flexibility in the supporting springs. Owing to this cause, in fact, it has been found that, no matter how carefully the gearing is cut, it wears out with astonishing rapidity and makes an intolerable noise. The vibration set up, too, shakes the armature to pieces, unless some elastic coupling is introduced between the pinion and the spindle; but this expedient only introduces fresh and undesirable complications. Up to the present the best results have been obtained by building up the pinion of cogged discs of bronze and discs of raw hide clamped together on the shaft. The whole is then put in a cutting engine, and the length of a cog is composed of, say, six hide and seven bronze sections. Pinions made entirely of raw hide have been tried, but they are too susceptible to the influence of the weather to be satisfactory. Endless screw gear is only adapted to locomotives moving at slow speed, because the reduction is much greater than is really needed. It has been used with motors making 2,000 revolutions per minute. We regard it as entirely out of the question for any engine intended to run at 30 or 40 miles an hour. Within a comparatively recent period, electricians have succeeded in producing slow speed motors of very high efficiency and powerful torque, and it seems to us that in these is to be found the solution of the problem. They are necessarily very heavy, but this is not a defect. It is just as easy to carry heavy field-magnets, as so much dead weight of pig iron. Bearing these facts in mind, it appears that an efficient electric locomotive could be made with three pairs of driving wheels of, say, 6ft. in diameter, each provided with an independent motor, the armature spindle being a tube through which the driving wheel axle can pass. The tube would revolve in ball bearings with very little friction. The internal diameter would be about 10in., the driving wheel axle 7in., so that it would be clear of the armature hollow axis all round by 1½in., which would allow quite enough play in the springs. Suitable drag links would then couple the armature to the driving wheels, which would make 287 revolutions, nearly, to the mile, or at 40 miles an hour about 192 revolutions per minute. A smaller wheel would perhaps be desirable, but that would not leave sufficient room for the armature. All three armatures would be needed to start the train, but as speed got up first one and then a second armature might be switched out. That there are objections to this design is indisputable, but it entirely gets rid of gearing, and possesses some excellent features which may suffice to much more than counterbalance its defects.

So far we have only spoken of comparatively small speeds; but the United States engineers contemplate the adoption of speeds of over 100 miles an hour for passenger trains—and there is really nothing ridiculous in the scheme. It is a noteworthy fact that Mr. Crosby has driven on an experimental circular railway, about two miles in circumference, a locomotive weighing about 2½ tons, at a velocity of 100 miles an hour. The road was not very good, but the resistance did not exceed 20lb. per ton. On the 20th of May Mr. Crosby read a most elaborate paper before the American Institution of Electrical Engineers, on "The Limitations of Steam and Electricity in Transportation." Unfortunately the conditions obtaining in the United States are so different from those controlling railway expenditure in this country, that much that Mr. Crosby has to say would be useless to English engineers as a guide in practice. Thus, for example, in estimating the relative cost of the two systems of transport represented by steam and electricity respectively, he shows that the consumption of fuel on the Pennsylvanian Railroad is 50lb. per train mile, and 5lb. per horse-power per hour. The American locomotive he considers to be much less economical than a stationary engine of the same power. This is quite opposed to English experience. Our locomotives are very economical engines, and do not burn more than 3lb. of coal per horse-power per hour, and possibly much less. It follows that calculations based on the assumption that fixed steam-engines generating electricity will be more economical than locomotives, must be greatly discounted in this country. Mr. Crosby sums up the conclusions at which he has arrived in the following words: 1. A slow speed armature placed on the car axle would place the electric motor in the lead at all service speeds. 2. For speeds above 70 miles per hour an electric motor of 90 per cent. efficiency, working through gearing of 90 per cent. efficiency, would prove more economical than the steam locomotive—save in cases of very infrequent service on very long lines. 3. On lines for heavy traffic steam would be more economical than electricity if motor and gearing have a combined efficiency as low as 60 per cent., up to 100 miles per hour. 4. At speeds of 100 miles per hour and upward, neither steam at 90 per cent. nor electric apparatus at 60 per cent. efficiency is commercially practicable. 5. Inasmuch as the saving of coal in stationary, as compared with locomotive engines, is one of the chief causes of the greater economy of electric propulsion, at any speed, this advantage will increase with that difference and also with the price of coal. 6. Any cause other than inefficiency of motor which increases the power required to haul a ton of freight, increases the advantages of electricity, since it enlarges the value of the coal difference and the dead-weight difference. Thus, bad roadways and large areas exposed to atmospheric resistance, as in street railway work, lower the speed at which electric motors of any efficiency become cheaper than steam. 7. In descending to small locomotive units, the electric motor loses less, relatively, of its advantage, another reason for success on street lines. 8. Multiplying the number of motors should be, as far as possible, avoided. 9. In special cases cleanliness and compactness of electric machinery may be of great value. In case of very frequent stops, the possibility of returning to the line the energy now wasted in brakes may be of considerable value. This, however, can be obtained only by sacrifice in the matter of dead weight, as normal working is implied to be at comparatively low magnetisation. Loss due to low efficiency in starting can scarcely be avoided either in steam or electric engines.

It will be seen that our proposal that slow speed motors, acting directly on the driving axle, should be used is in strict accord with Mr. Crosby's views. Paragraph 5 contains an argument which, as we have shown, loses much of its force as regards this country. Mr. Crosby gives a table, obviously prepared with great care, showing the cost of electricity in the United States:

ELEMENTS OF THE COST OF 1-HORSE-POWER HOUR, ELECTRIC, IN CENTS.

Capacity	100	300	500	800	1,000	1,500	2,000	3,000	4,000	5,000	6,000
Engineer	0·4	0·13	0·08	0·05	0·04	0·04	0·04	0·04	0·04	0·04	0·04
Fireman	0·3	0·10	0·06	0.037	0·03	0·03	0·03	0·03	0·03	0·03	0·03
Dynamo man	0·4	0·13	0.08	0·05	0·04	0·04	0·04	0·04	0·04	0·04	0·04
Helper	0·25	0·08	0·05	0·031	0·025	0·025	0·025	0·025	0·025	0·025	0·025
Superintendence ...	0·30	0·10	0·06	0·037	0·03	0·02	0·015	0·001	0·001	0·001	0·001
Coal	0·475	0·475	0·475	0·475	0·475	0·475	0·475	0·475	0·475	0·475	0·475
Oil, waste and water..	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15
Interest and depreciation, steam plant ..	0·057	0·051	0·044	0 033	0 028	0·022	0·022	0·022	0·022	0·022	0·022
Ditto, electric plant..	0·057	0·051	0·044	0·033	0·028	0·022	0·022	0·022	0·022	0·022	0·022
Ditto, building	0·028	0·026	0·022	0·168	0·014	0·011	0·011	0·011	0·011	0·011	0·011

We presume that this represents the results obtained in actual practice in the United States, but the figures are by no means above criticism. For example, it will be seen that he takes the cost of coal, oil, waste, and water at precisely the same figures per horse per hour for an installation of 100 h.p. and an installation of 6,000 h.p. But it goes without saying that the outlay on these items ought to be very much less for the large than it is for the small installation. Again, Mr. Crosby gives 60lb. per horse-power as the weight of the electric locomotive, and goes on to express a hope that this may be reduced. But he is obvious of the fact that 60lb. may not be enough for adhesion. Thus, an electric locomotive capable of exerting 500 h.p. would weigh but 60 × 500 = 30,000lb., a little over 13 tons; or about one-half the weight necessary to secure adhesion enough to utilise the power which the motor could exert.

We have felt it to be desirable to criticise some of Mr. Crosby's arguments, but it is beyond question that his experiments place him in the front rank as an investigator. He is the first man who has ever run a vehicle at 100 miles an hour on what is virtually a real railway; and it is perhaps not too much to say that he has done more than anyone living to ascertain what the true law of railway resistance is. The following passage so strongly confirms what we have said to explain the cause of the discrepancy between his data and those obtained by other experimenters, that we cannot refrain from quoting it: "For the most part those who constructed the formulæ now found in text-books, worked on roadbeds far inferior to the best work of to-day, at speeds much less than those now attained, and with wrong values for at least one of the species of resistance—the atmospheric. On this point I have recently been able to present as the results of experiments at high velocities, made by Mr. B. J. Dashiell, jun., and myself, a formula showing the pressure to be a function of the first, instead of the second, power of the velocity, as ordinarily assumed. A convenient datum point may be given stating that at 100 miles per hour the pressure on one square foot, normal to the direction of motion, is 13lb., while proper shaping of the front may reduce this 6·5lb. The absolute value given, while corresponding quite closely with those of received formulæ in the neighbourhood of the velocities heretofore experimentally attained, depart from those assumed for velocities higher than 30 miles per hour, and calculated by the quadratic relation betwen velocity and pressure. Using the more trustworthy values, I have been able to separate more nearly than has heretofore been possible the atmospheric from all other resistances met at high velocities. Some inaccuracy still remains, by reason of the difficulty of obtaining exact measure of the resisting areas in a train, but I have been able by study of careful tests made by others on the New York Central and on English roads to find that over the range from about 40 up to 80 miles per hour the tonnage coefficient seems practically constant at 8lb. This, of course, applies only to first-class roadbed and rolling stock. Whether this coefficient remains constant at higher speeds we do not know. There is no reason to assume, as has often been done, that it increases with the square of the velocity, and, on the other hand, it will not be safe to assume constancy. From experiments made with a single 2·5 tons car at about 100 miles per hour, the tonnage resistance at that speed seems to be about 20lb. per ton. Though this value seems quite high as compared with the 8lb. at 85 miles per hour, the difference is in large part to be explained by the poor condition of the track used for the experiment, and a constant curvature which would call for about 4lb. per ton. Until better evidence can be had it will be safe at least to assume a value of 20lb. per ton, on a first-class track, with good rolling stock, at 125—150 miles per hour."—*The Engineer.*

THE LIMITATIONS OF STEAM AND ELECTRICITY IN TRANSPORTATION.*

BY O. T. CROSBY.

(Continued from page 474.)

Dynamo plant is taken to vary from 50dols. to 20dols. per horse-power in going from 100 h.p. to 1,500 h.p. I know that machinery of good design can be manufactured for these prices.

The cost of buildings is taken to vary from 25dols. to 10dols. per horse-power. This is the most indefinite item. Interest, maintenance, and taxes are roundly assumed at 10 per cent. per annum on the whole plant.

With Table II. as a basis, Table III. has been calculated, giving total cost per horse-power hour in stations of various capacities, working at various percentages of full capacity, and for 24, 18, and 12 hours per day respectively.

TABLE III.—Total cost of 1 h.p. hour in cents.

Output in per cent. of capacity while working.	Hours of work per day.	Capacity of station.							
		100	300	500	800	1,000	1,500	2,000	3,000
100	24	2·42	1·29	1·06	0·9148	0·860	0·835	0·825	0·816
,,	18	2·52	1·36	1·115	0·938	0·888	0·855	0·849	0·829
,,	12	2·85	1·52	1·228	1·028	0·955	0·95	0·895	0·867
90	24	2·62	1·36	1·12	0·947	0·88	0·86	0·85	0·83
,,	18	2·77	1·45	1.17	0·98	0·91	0·88	0·87	0·853
,,	12	3·10	1·61	1·29	1·06	0·99	0·94	0·925	0·89
80	24	2·87	1·45	1·18	0·987	0·92	0·91	0·88	0·86
,,	18	3·06	1·55	1·23	1·03	0·98	0·936	0·926	0·90
,,	12	3·42	1·73	1·37	1·13	1·06	1·000	0·98	0·95
70	24	3·19	1·57	1·26	1·04	0·96	0·925	0·91	0·89
,,	18	3·42	1·68	1·32	1·09	1·01	0·952	0·94	0·91
,,	12	3·82	1·90	1·48	1·19	1·09	1·02	1·01	0·97
60	24	3·62	1·73	1·36	1·11	1·01	0·975	0·96	0·94
,,	18	3·85	1·85	1·44	1·16	1·06	1·015	1·00	0·965
,,	12	4·31	2·11	1·63	1·30	1·17	1·085	1·07	1·015
50	24	4·22	1·95	1·52	1·20	1·10	1·045	1·03	1·00
,,	18	4·50	2·10	1·61	1·27	1·15	1·09	1·076	1·039
,,	12	5·09	2·40	1·83	1·43	1·28	1·19	1·17	1·114
40	24	5·11	2·28	1·73	1·35	1·21	1·15	1·13	1·10
,,	18	5·47	2·48	1·88	1·44	1·33	1·25	1·23	1·17
,,	12	5·20	2·82	2·17	1·64	1·50	1·38	1·35	1·28
30	24	6·63	2·84	2·10	1·59	1·40	1·325	1·30	1·26
,,	18	7·08	3·02	2·27	1·71	1·51	1·40	1·38	1·32
,,	12	8·06	3·52	2·65	1·98	1·73	1·57	1·54	1·44

A glance at the table shows that in a 100 h.p. plant the cost varies from 2·42 cents for a 24-hour run at full capacity, to 8·06 cents for a 30 per cent. output continued only 12 hours per day.

This extreme case would doubtless be ameliorated by dropping the superintendence and combining engineer and fireman, though to this the unions might object. This capacity is smaller than need be considered for any steam line service.

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* A paper read before the general meeting of the American Institute of Electrical Engineers, Boston, Mass., May 20, 1890.

The minimum cost given by the table is 0·816 cent, this for a 300 h.p. plant working full capacity 24 hours per day.

The next element of cost, that of the conductors for the current, is obtained from Table IV., showing investment in dollars for the copper required to transmit 1 h.p. a distance of one mile at varying initial and final pressures. The constants for this table were thus obtained: Taking a well-known line wire I find that from No. 4 to No. 000 B.W.G., the average weight ratio of insulated to bare wire per unit of length equals 0·844. When bare copper sells at 15 cents, this insulated wire sells at 20 cents = 22·5 cents on the copper alone when insulated. If, therefore, we take copper at 25 cents per pound, we provide for a very good insulation. The cost of one mil-mile is thus found to be 0·004dols. Combining this with the familiar formula

$$\mathrm{C\,M} = \frac{16{,}600 \times \text{horse-power transmitted} \times \text{distance in feet.}}{\text{E.M.F. at motor} \times \text{volts lost on line} \times \text{motor efficiency},}$$

the tabulated values have been determined from the resulting formula:

$$\mathrm{Cost} = \frac{760{,}320}{(\mathrm{E}-\mathrm{V})\ \mathrm{V}}, \quad . \quad . \quad . \quad . \quad . \quad (1)$$

in which E = E.M.F. at station, V = volts lost on line; motor efficiency is taken at 90 per cent., and distance at 5,280ft. The tabular figures give the investment. To reduce to actual cost per horse-power hour, rate of interest and depreciation, and ratio between power transmitted and power possible to be transmitted. For one year the possible horse-power hours = 365 × 24. Take annual interest and depreciation at $\frac{1}{15}$ the investment and ratio of actual to possible power transmitted per annum at 1·0, 0·8, 0·6, 0·4, 0·2, 0·1, 0·05, then the divisor of the tabular number becomes 140,160, 112,128, 84,096, 56,064, 28,032, 14,026, and 7,008 respectively.

It remains to obtain values for the distance of transmission.

Let n = number of miles of line supplied from one station.

h = horse-power required for unit locomotive.

K = maximum number locomotives per mile at any time.

$n\,h\,\mathrm{K}$ = total power to be transmitted at time of K.

A = percentage of dynamo power lost on line.

$\frac{n\,h\,\mathrm{K}}{100-\mathrm{A}}$ = maximum power to be generated.

$\frac{m\,h\,\mathrm{K}}{100-\mathrm{A}'} \times \frac{\mathrm{A}}{100}$ = ,, ,, lost on line.

b = cost in cents of generating one horse-power hour in station.

r = ratio of average power required to maximum power required.

L = interest and depreciation on supporting structure.

This last may be omitted from the calculation, determining division of line into sections, since it remains the same, whatever that division may be. Omitting this, the expression for cost of transmission becomes:

$$\mathrm{Cost} = \frac{760{,}320\, n^3 h\, \mathrm{K}\, r}{(\mathrm{E}-\mathrm{V})\ \mathrm{V} \times 140{,}160} + \frac{b\, n\, h\, \mathrm{K\,A}}{r\,(100-\mathrm{A})\,100}.$$

$$= \frac{5{\cdot}42\, n^3 h\, \mathrm{K}\, r}{(\mathrm{E}-\mathrm{V})\ \mathrm{V}} + \frac{b\, n\, h\, \mathrm{K\,A}}{r\,(100-\mathrm{A})\,100} \quad . \quad . \quad . \quad (2)$$

Supposing that the time schedule of trains, horse-power required per train, and efficiency of motors be known, and that the initial E.M.F. be in all cases taken as high as the state of the art permits, the only variables remaining in this expression are n, b, and A. This latter, the value for the drop on the line, will generally be determined by conditions other than those of strictest economy, as shown by getting a minimum value for cost of transmission. We must have a reasonably uniform E.M.F. all along the line in order that the motors may work satisfactorily. It will not be wide of the mark to assume 10 per cent. as a limiting variation of line potential. This is the figure generally assumed in calculating wire for street railways.

The cost of one horse-power hour, b, must vary with the capacity and conditions of working of the station; hence it is a function of n—*i.e.*, length of unit section—of A, and of that inexpressible variable—the conditions of the service. This stands in the way of obtaining any perfectly general definite expression for n, which, but for this, would result from placing the first differential coefficient of C, with respect to n, equal to zero, and solving to find the value of n, giving a minimum value for C. If trains be run at very short intervals, increase of n would be followed by proportional increase in capacity of station; but, as above shown, this need not go beyond 3,000 h.p. unless the service be so heavy as to require practically contiguous stations of that capacity. If we suppose a case of this short-interval service, so short that a change in n will not be followed by any change at the station in the relation between maximum capacity and average output, or in the number of working hours, but only in the normal capacity, the relation between b and n for two cases of average output and working hours is shown by Fig. 1. The equation of the 50 per cent. curve from 200 h.p. to 1,000 h.p. seems to be very nearly

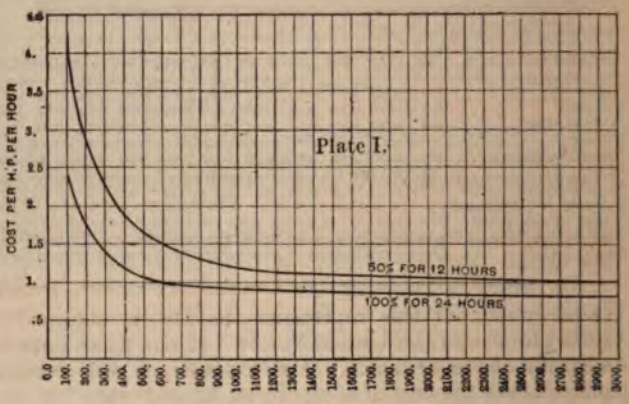

FIG. 1.

$$b = \frac{n^2 - 98\,n + 1{,}000}{12\,(n-100)}.$$

If the trains be run at very long intervals we may require no greater station capacity for 20 than for 10-mile sections; but the relation of output to normal capacity will vary, and possibly the number of hours during which the working force would require to be kept on pay.

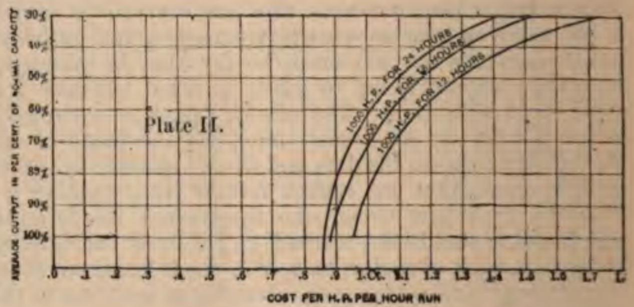

FIG. 2.

Taking the case of a change on average output only, for a 1,000 h.p. station, we have the curves in Fig. 2, for 24, 18, and 12 hours' work. Their equations are nearly of the same form, and are approximately the equations of arcs of circles referred to an origin outside the circle. But each would contain different constants, and would vary more or less from the exact formula for the circle.

If, in the application to a particular case the algebraic expression for b above given, or any other resulting from any of the possible progressions through Table III., be substituted in equation 2, we may, by differentiation, solve that particular case for the most economical value of n. If the relation between b and n cannot be algebraically expressed, then the proper value for n may be determined by a few

TABLE IV.—For Double Metallic Circuits.

Copper Investment for Transmitting 1 h.p. one mile.—Motor Efficiency = 90 per cent.—Initial E.M.F.

Drop on line, volts.	500	1,000	1,500	2,000	2,500	3,000	3,500	4,000	4,500	5,000	5,500	6,000	7,000	8,000	9,000	10,000
100	19·00	8·44	5·42	4·00	3·20	2·60	2·20	1·80	1·60	1·44	1·40	1·28	1·10	0·98	0·84	0·76
200	13·66	4·80	3·42	2·12	1·64	1·34	1·14	1·00	0·88	0·78	0·70	0·64	0·56	0·48	0·42	0·38
300	19·00	3·60	2·12	1·50	1·20	0·94	0·80	0·68	0·60	0·54	0·48	0·44	0·36	0·32	0·28	0·26
400	...	3·20	1·72	1·20	0·92	0·72	0·60	0·52	0·44	0·40	0·34	0·32	0·28	0·24	0·22	0·20
500	...	3·00	1·50	1·00	0·76	0·60	0·50	0·40	0·36	0·34	0·30	0·28	0·22	0·20	0·18	0·16
600	...	3·20	1·40	0·92	0·66	0·54	0·42	0·34	0·32	0·28	0·26	0·22	0·20	0·16	0·15	0·14
700	...	3·60	1·34	0·82	0·60	0·46	0·38	0·32	0·28	0·24	0·22	0·20	0·16	0·14	0·12	0·10
800	..	4·80	1·34	0·80	0·56	0·42	0·34	0·30	0·26	0·22	0·20	0·18	0·14	0·12	0·10	0·10
900	..	8·44	1·40	0·76	0·54	0·40	0·32	0·28	0·22	0·20	0·18	0·16	0·14	0·12	0·10	0·08
1,000	...	...	1·50	0·76	0·50	0·36	0·30	0·24	0·20	0·18	0·16	0·15	0·12	0·10	0·08	0·08
1,200	...	...	2·12	0·80	0·48	0·34	0·28	0·22	0·18	0·16	0·14	0·12	0·10	0·08	0·08	0·07
1,400	...	...	5·42	0·90	0·48	0·33	0·26	0·20	0·18	0·14	0·12	0·10	0·08	0·08	0·06	0·06
1,600	...	...	...	1·12	0·52	0·34	0·24	0·20	0·16	0·14	0·12	0·10	0·08	0·06	0·06	0·056
1,800	...	...	...	2·12	0·60	0·34	0·24	0·18	0·16	0·12	0·10	0·09	0·08	0·06	0·06	0·05
2,000	...	...	...	...	0·76	0·36	0·24	0·18	0·15	0·12	0·10	0·08	0·06	0·06	0·054	0·046
2,400	...	...	...	...	3·20	0·52	0·28	0·20	0·14	0·12	0·10	0·08	0·06	0·05	0·048	0·04
2,800	...	...	...	...	...	1·34	0·38	0·22	0·16	0·12	0·09	0·08	0·06	0·05	0·04	0·038
3,200	...	...	...	...	...	...	0·78	0·30	0·18	0·12	0·10	0·08	0·06	0·05	0·04	0·034
3,600	...	...	...	...	...	...	...	0·54	0·22	0·14	0·10	0·08	0·06	0·05	0·04	0·032
4,000	...	...	...	...	...	...	...	...	0·36	0·18	0·12	0·08	0·06	0·04	0·038	0·032
4,500	...	...	...	...	...	...	...	...	...	0·60	0·16	0·10	0·06	0·04	0·036	0·030
5,000	...	...	...	...	...	...	..	...	...	...	0·30	0·15	0·06	0·04	0·038	0·030
6,000	...	...	...	...	..	..	...	...	...	...	...	...	0·12	0·06	0·04	0·032
7,000	...	...	...	...	...	...	...	...	...	...	...	...	...	0·10	0·054	0·036
8,000	...	...	...	...	...	...	...	...	...	...	...	..	...	...	0·08	0·046
9,000	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	0·008

In using the table it will be convenient to draw curves of equal cost. They will be, roughly, arcs of circles convex toward the left.

trial values, the corresponding values of b being taken from the table.

For the present purposes of comparison we will assume a case not more favourable than might often be met on busy steam lines—*i.e.*, a station of 2,000 h.p. normal capacity, working 18 hours per day at 40 per cent. of its normal output, the cost per horse-power being 1·25 cents.

To obtain the cost of the line, we will assume that the average distance of transmission is five miles. This would correspond to one station for every 20 miles of road. We will also assume 5,000 volts initial E.M.F. and 10 per cent. drop. From Table IV. the copper investment is found to be 34 cents for one mile. Then for five miles the investment equals 8.50dols. Making assumptions as to service corresponding to those for the station, we have cost of 1 h.p. equalling 8.50dols. ÷ 20,000 = 0·042 cent.

The structure for carrying the conductors may be built for 2,000dols. per mile. Interest and depreciation would then become 200dols. per annum. This total is almost wholly independent of the power transmitted, hence the cost per unit of power will vary directly with the number of units transmitted. Assuming a constant distribution of one 500 h.p. train for every 20 miles of line, we have the cost of this item for 1 h.p. hour.

$$20{,}000 \div 365 \times 24 \times 25 = 0·09 \text{ cent.}$$

Reaching the locomotive, we must add, supposing an average output of 500 h.p., 0·08 and 0·06 cent. respectively for driver and his assistant. The latter is necessary only as a substitute for his principal in case of emergency, but as such he would doubtless always be placed on trains of considerable value.

Repair on electric locomotives is not as yet well defined. That the repair bill must be far less than in the case of steam locomotives follows almost necessarily from the great reduction in the number of parts, especially of moving parts.

From Mr. Arthur Wellington's very valuable work on railways I take the figures showing percentage distribution of locomotive repairs by parts.

Boiler, 20 per cent.; running gear, 20 per cent.; machinery, 30 per cent.; lagging and painting, 12 per cent.; smoke-box, etc., 5 per cent.; tender (running gear, 10 per cent.; body and tank, 3 per cent.), 13 per cent.; total, 100 per cent.

Of these items we may at once, and with certainty strike out boiler, smoke-box, etc., and tender, thus dropping 38 per cent. of the total. Having no boiler to carry, the running gear will be less in quantity.

The wear will be less, due to the use of rotary instead of reciprocating effort. It will then be fair to reduce this item by half, making another saving of 10 per cent. So in the machinery item there can be no question that with the rapid advance towards slow-speed motors, reducing gearing, and sounder insulation methods, the great advantage of having only *one moving part* in the motor itself must operate to very largely reduce the repair figure, probably to half its value in a steam locomotive, leaving it at 15 per cent. In lagging and painting the omission of boiler and other parts must again affect a reduction, say, to 6 per cent. The total induction thus plainly indicated must be then very nearly 70 per cent.

The actual cost of repairs to-day on steam locomotives is on the P. R. R. nearly 0·75 per cent. per horse-power hour, as will later appear. Reducing as above, this figure becomes 0·22 per cent. for electric traction. This refers to engines of considerable power, say, from 400 to 1,000 h.p. capacity. The figure for both steam and electric motors would go up for smaller powers.

The interest charge results from considering the cost of an electric locomotive as 50dols. per horse-power and the duty as six hours per day full capacity. The average duty of steam locomotives is only about three hours. The higher figure results from a smaller number of repairs necessary, due to greater simplicity of parts. Then

$$\text{Interest for horse-power hour} = \frac{50·00 \times 0·05}{365 \times 6} = 0·11 \text{ cent.}$$

Before summarising we must know something of the efficiency of the system. If the locomotive be of 90 per cent., or 80 per cent., or 60 per cent. efficiency, we must generate respectively 1·25, 1·4, and 1·85 h.p. hour in the station for every horse-power hour actually delivered to drivers, line loss being supposed constant at 10 per cent. We should then have in the station 1·56, 1·75, and 2·30 cents respectively. Then for total:

Station.	1·56	1·75	2·30
Conductor system............	0·042	0·04	0·04
Structure for same	0·09	0·09	0·09
Wages............................	0·14	0·14	0·14
Repairs	0·22	0·22	0·22
Interest	0·11	0·11	0·11
Total	2·16	2·35	2·80

Of the whole amount it is to be noted that the station item is three-fourths. Taking the most favourable case shown by the table—3,000 h.p. capacity, working for 24 hours at 100 per cent. of capacity—these figures become 1·5, 1·62, and 2·00 cents nearly, the reductions in the other items being still a little indefinite, without making another series of independent assumptions.

(To be concluded.)

ELECTRIC WELDING.

The Electric Welding Syndicate have obtained several very satisfactory reports on the process introduced by them. The most important of these reports are perhaps those of Prof. Kennedy and Sir F. Bramwell. The former gentleman made a special visit to America in order to investigate more fully the process, and evidently found a good deal to interest him. That Sir F. Bramwell was similarly interested is perhaps shown not only by his report, but also by his contributing papers on the subject to the Institution of Civil Engineers, and to the Society of Arts. We herewith give Prof. Kennedy's report:

In accordance with your instructions I have visited the United States in order to see what progress has been made there in the direction of the practical carrying out of the Thomson electric welding process. I have visited the offices of the Thomson Electric Welding Company at Boston, and have also spent about a week at their works at Lynn, Massachusetts, at both of which places I have had every facility given me for making all possible enquiries, experiments, and investigations. I have also visited five different works in the Eastern States (at Hartford, Ansonia, Brooklyn, and Trenton), where Thomson electric welders of various types have been in use for some time (in some cases over a year) commercially, and have made detailed enquiries at these places as to their working.

I have brought to England a series of about 80 specimens, large and small, of the principal different classes of work which have been already carried into execution by the Thomson process. All these specimens have been made in my own presence either at Lynn or elsewhere, nearly all on machines made on order for, or which are now in actual use for, commercial purposes. In most cases I have measured both the time taken in the operation of welding, and the electrical power consumed in the operation.

In the following report the statements made as to dates of establishment of the Lynn Works, dates of making machines, number of machines constructed, and similar matter, are made on the authority of Mr. Royce, the general manager of the Thomson Electric Welding Company. All statements, however, as to work actually done, nature and behaviour of machines, power used, quality of weld, speed of working, etc.; as to everything, in fact, which I could verify, are made as the result of my own personal examination, unless the contrary is directly stated. I say this here, once for all, in order to save repetition.

As I understand that Prof. S. P. Thompson is reporting to you upon the Thomson process specially from the electrical point of view, it is unnecessary that I should go into this matter. I need only mention that in all but one or two of the machines which I saw the actual welding current used was an alternating current reduced by a transformer (which formed constructively a part of the welder) to an E.M.F., often very much less than one volt. That such a current is absolutely free from danger will be easily understood when it is remembered that the lowest E.M.F. commonly used for an ordinary glow lamp is 50 volts. In what follows I have given details as to the time during which the current is used in the various operations described. This varies, of course, according to the size and shape of the metal to be welded; for a fine wire it is only a second or two, for a piece of iron bar of 2in. diameter it is from 90 to 100 seconds, in which last case the whole time occupied from the putting in of one pair of pieces until the putting in of the next is from 2½ to 3 minutes. The current is under entire control during the whole operation, which can be quickened or prolonged at will within wide limits. The metal can be kept for any length of time at any temperature short of its melting point, or it can be allowed to cool and reheated over and over again if required.

The works of the Thomson Electric Welding Company, at Lynn (Mass.), were started about a year since, but have only been finished about five months. They now employ about 250 men, and I found the shops stocked with excellent tools and full of work, which consisted entirely of Thomson welders and the dynamos for working them. Up to the time of my leaving America 36 welders of all types, with the necessary dynamos, had been actually delivered at works in various parts of the United States, while 43 others were in hand in the shops on order for different commercial processes.

The following is a summary of the work on which these machines are, or are intended to be, engaged:

Iron and steel wire	9
Hard steel (gun) wire	2
Copper and brass hardware	8
Copper rods, etc., to 1in. diameter	4
Pipe from 2in. to 6in. diameter	4
Axles, tyres, and waggon work	35
Miscellaneous hardware	7
Brazing and welding	3
Upsetting collars on axles	2
Steel wire cable welding	2
Lead strips	1
Street rail splicing	1
Upsetting bridge eye bars (6in. by 1in.)	1
	79

The welding of iron and steel wire was one of the first matters successfully carried out by the company. I saw at the works of Messrs. Roebling, Sons, and Co., at Trenton, a welder which had been at work there for about 13 months, for a great part of the time 20 hours per day, and the counter of which showed that 193,890 welds had been made with it. I also examined another wire welding machine at the Trenton Iron Works (Messrs. Cooper, Hewitt, and Co.), which had done about nine months' work, and had made 22,095 welds, and at the same works a portable machine, recently installed, which had made 9,022 welds. This last machine was so arranged that it could be carried about easily by two men, and connected with the mains at any part of the immense shop in which it was placed, so as to be used for mending or other welding wherever required, without the necessity of bringing a heavy coil of wire to it. The managing partners of both the works spoke in the highest terms of the efficiency of the machines, and as to the great saving caused by their perfect utilisation of short lengths and broken wires. They also considered it an immense advantage that they were now able to deliver in longer lengths to the telegraph companies, so that the only joints in a telegraph line need be those made by the linesmen in erection. The substitution of a welded joint for any of the ordinary twisted ones, which they had previously used, had been found to be of great advantage from the point of view of electrical conductivity; and I was informed that the Western Union Telegraph Company had now made it a condition in their specification that all wire delivered to them should be electrically welded.

The fact that the wire was galvanised caused no difficulty in connection with the welding.

The welding of brass and copper wire, especially the latter, naturally presented much greater difficulties than that of iron wire, but these seem now to have been overcome. I saw at the works of Messrs. Wallace and Sons, in Ansonia, a welder for this purpose which was one of the first machines put down, and had made 30,415 welds (by register) during the last 13 months* in copper and brass wire, the latter in certain cases of the very hard and poor quality used for making pins. I found the machine placed between the wire-drawing room and a winding-room. It was at the time being used for welding coils of brass wire into continuous mile lengths (12 coils to the mile length). The wire was about ⅛in. diameter, and of a very good quality of brass. Beside the welder stood a little machine for straightening the ends of the coils before putting them into the welder, and also a small machine for removing the burr after the weld had been made. The whole time taken in welding together the 12 coils, including all the handling of the coils, the straightening, and the burr removal, was about 25 minutes.

Stout copper wire was at the time being reeled in an adjacent shed, and every now and then this would break in the winding. The winders simply hauled the two broken ends along to the welder, and the other work there was stopped for a couple of minutes while the broken copper coil was mended. After this mending the copper wire was as perfect, both in strength and conductivity, as before. Thus absolutely no wasters were made through breakages.

I had five short pieces of the brass wire welded together into a length of about 18in. and the burrs removed (the whole operation only taking four or five minutes), and then took the welded pieces to the wire-drawer and had it passed six times through the dies, reducing its diameter from 0·12in. to 0·031in. The existence of the four welds made no difference whatever in the drawing (which was continued until the diameter was reduced to about 0·002in.), and I was assured by Mr. Wallace that this was the case just as much with inferior qualities of brass.

At present machines are being made specially for copper wire, in which the pressure is put on and the current thrown off automatically; thus making copper wire even easier to handle than iron wire. I worked one of these machines myself, at Lynn, and its action seemed to me perfect.

The axle and tire machines which have been made hitherto are mostly for small carriage or buggy work, where the axles are about 1¼in. diameter and the tires about 1¼in. by ¼in. I saw at Brooklyn, however, at the workshop of the New York Fifth Wheel Company, a somewhat larger machine of the same type, used for welding the channel-shaped rims of "Fifth Wheels,"† up to 2⅜in. by 1in., with a section of about 1¼ square inches. These tyres, which were of mild steel, were first bent round cold to about 3ft. diameter, and then placed in the machine and welded up, the weld being tightly hammered after being taken out. I had six welds made in succession, and the average time per weld, including hammering, was just four minutes. The burr was removed afterwards on an emery wheel, an operation which took about three minutes more. I was told by the manager of the works, as well by the smith, that the welding of these tyres in a fire took from 30 to 45 minutes each.

In order more thoroughly to examine the conditions of straight butt welding in ordinary sections, I made a number of experiments at Lynn on machines which were being finished for various customers. In these experiments, as it was impracticable to measure the power going to the dynamo, I measured (by means of instruments which I calibrated myself) the net electrical power going to the welder, and I measured also the exact time during which the current was supplied to the welder. I made these measurements on 25 pieces of wrought iron and steel bar of diameters varying from ½in. to 2in. I did not find any sensible difference between the iron and the steel in respect to power or time. The horse-power required varied, of course, according to the duration of the operation, and it has been found convenient to make this duration vary directly in proportion to the diameter of the bar, taking 40 seconds as the standard time for an iron bar of 1in. diameter. Keeping to these conditions, the horse-power per square inch of material remained very nearly constant for bars between ½in. and 1½in. diameter, its average value being 20·8. This corresponds to about 30 *indicated horse-power* at the steam-engine per square inch of welded section during the time that the current was on. This power can be very largely reduced without detriment to the weld if the saving of power should be of greater importance than the saving of time. Of course, with slower working, the quantity of work which a machine will turn out is proportionately decreased.

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* During about four months of this time the firm were not buying copper, and the machine was standing idle. At other times it has been frequently worked 14 hours per day.

† "Fifth Wheel" is the name used in the States for the bogie ring of the front carriage of a waggon. In this particular case the ring was made of channel section to form a roller path, and so reduce friction.

The 2in. diameter wrought-iron bars were welded on a machine better adapted for this class of work, and with an average time of 97 seconds—a proportionately slower rate than that given above. The actual average net horse-power was only 12·0 per square inch, or about 17 gross indicated horse-power per square inch of section welded.

Although it was more convenient to carry out the measurements which I have just summarised in connection with the welding of straight bars than of irregular sections or shapes, the latter operation is unquestionably that in which the Thomson process shows to the greatest advantage. Thus in the channel sections which are being welded by the North York Fifth Wheel Company, the time of operation is reduced from 40 down to six or seven minutes, including the time occupied in grinding off the burrs, while the quality of the weld is much improved. As there was not a welder at work on carriage hardware within an accessible distance of Boston, I had a number of L and T welds made in 1¼in. by ⅛in. bar at Lynn. These took on the average less than two minutes per weld, including a little hammering both during and after the operation, the current being on about one minute. I had also a number of ⅜in. hard steel spindles welded to the centre of hard steel cutter discs about 1½in. diameter, an operation so difficult as to be practically impossible by any other method. These welds were made, without any notice, at my request, on the brasing welder at Hartford mentioned below, and although no preparation had been made for them three were finished for me in 10 minutes.

With the Thomson welders the difference between operations of the kind just mentioned and the making of simple straight welds appears to be essentially one of detail in the arrangement of the clamps which hold the pieces operated on, the machine itself and its method of working not differing much in different cases.

The butt welding of tubes, which has been carried out commercially with success, is an illustration of this. I found that 2½in. iron tubes, ¼in. thick, were welded in 61 seconds, the net horse-power required at this speed being 23·4 (say 33 indicated horse-power) per square inch of section. I also had some 1⅛in. brass tube, ⅛in. thick, welded to iron tube of same size, which I found to require 21·2 net horse-power (say, 30 indicated horse-power) per square inch of section, the current being on 24 seconds for each weld. In some of these cases, as in others which I have already mentioned, a little light hammering was done on the weld. Machines have been delivered and at work, I was informed, for some time commercially, for the welding up of refrigerator coils in iron pipe, and also for the welding of brass "safe-ends" to boiler tubes. It is noteworthy that the burr formed at the tube weld all comes to the outside, and does not at all choke the tube. In the case of boiler tubes especially, the whole of the outer burr has to be removed by grinding or by hammering on a mandril, so as to make the exterior of the tube all accurately of the same diameter. I was informed that a machine was now designed to weld tubes up to 6in. diameter.

The welding of angle and tee irons (especially into elbows or frames) has not yet been undertaken. I see no reason to doubt, however, that it can be successfully carried out, for it is by no means so difficult an operation as some of those I have already described. About 60 total indicated horse-power would be required for the welding of angle irons 3in. by 3in. by ½in. in from two to three minutes. There would be no difficulty in so arranging the machine and the clamps that a number of welds could be made in different parts of one and the same piece of angle iron framework, for instance, so long as the frame was not too heavy to be conveniently handled.

The most difficult operations which I saw carried on in the welders were the welding of steel wire rope cables and the welding of copper bars 1in. diameter. Messrs. Cooper, Hewitt, and Co. (Trenton Iron Works) have taken up the manufacture in the States of patent "locked wire" cable, the making of spliced joints in which is a matter of the greatest difficulty. The cable is to be used for tramways, etc., where it will pass over pulleys of large diameter. By cutting the ends square and placing on them small iron rings to stiffen them, thoroughly good butt welds have been made in this cable, the rings being simply cut off after the weld is complete. I had some welds made in this way at Lynn on one of the ordinary welders in the shop, but a special cable-welding plant has been constructed for Trenton, and is now being erected there. The weld makes the cable practically into a solid bar for a length of from 1in. to 1½in. I have at present in hand mechanical tests of these and other welds, of which I hope to send you the results shortly. I saw, however, at Boston some of these cable welds, which had been tested with remarkably good results as to strength.

A welder to join copper bars up to 1in. in diameter was just being finished for the Tamarack and Osceola Copper Company, Dollar Bay, Michigan, when I arrived in America, and I saw a large number of tests made on this machine. The difficulty in welding copper of such dimensions arises not only from the enormous current rendered necessary by its high conductivity, but also by the suddenness with which it tends to melt just above the heat at which it welds. In this copper welder, therefore, the transforming coils were arranged to give an E.M.F. of only a fraction of a volt, so that the current would be many thousand amperes, while the endlong pressure was applied continuously and uniformly during the whole process by hydraulic pressure, from the water company's mains, in two small cylinders. The average time during which the current was on for a weld was 25·4 seconds (as compared with 40 seconds for iron of the same diameter), the actual average net horse-power being 45·1, or 57·4 net horse-power per square inch of copper at this speed, which corresponds to about 80 gross indicated horse-power per square inch of copper.

The Thomson welders have been used for brazing as well as welding. I found at the immense bicycle works of the Weed Sewing Machine Company in Hartford, Conn., a brazing welder which had been at work about nine months, and which had made, by register, 29,800 separate operations. When I saw the machine it was brazing the two limbs (tubes) of bicycle driving wheel forks into the cast-steel socket which joined them. The clamps were arranged so that the joint to be brazed stood vertically in the machine, and the brazing was applied in the form of fine wire previously twisted round the limb just above the socket. In this way it ran readily downwards, and, as I found on cutting a joint open, an excellent braze was made. I found that it took 10·5 minutes to make seven pairs of joints (previously wired) while a smith used to the work took 3½ minutes to one pair in the ordinary gas furnace. The electrically brazed fork was also much cleaner than the other, the borax and the heating had not spread nearly so much, and the work of finishing off would therefore be much less. The managing director of the works told me that he was now modifying the design of his bicycles throughout, with the special object of brazing or welding electrically as many joints as posible. He said further that one man working 10 hours a day was able now to average 180 double brazings per day in addition to the necessary preliminary cleaning and wiring of the work. It was on this brazing machine that I had the hard steel cutter discs welded, as I have mentioned above.

The welding of chain links in steel as well as in iron is a matter upon which the Thomson Welding Company are at present engaged, but which has not yet been carried out commercially. I had some links made from 1in. wrought-iron bar in an ordinary welder, the bar being previously bent into a U shape, and am now subjecting them to various tests. I can only express the opinion, based upon what I have seen of the experimental work as far as it has gone, that there is much probability of a satisfactory *steel* chain being turned out by this process, a result, I need not say, of very greatest importance, as hitherto it has been practically impossible to use anything but iron for chain-making.

The only chain-making machine which has been actually completed is one for making fine chain from wire about $\frac{1}{32}$in. diameter. This machine has with it another for cutting off and bending the wire. I had some chain made by it, and it was made at the rate of two links per minute, *including* the cutting and bending of the wire, and the cooling off of each link separately in water.

Two welders have been constructed, and are now erected in Indianapolis for the purpose of upsetting collars on buggy axles, the collar, bored slightly conical, being slipped on to the axle, and then secured by the upsetting of the metal within and on each side of it. I saw at the works at Lynn a number of upsets made on small iron bars both with and without the use of formers. This matter is still more or less in the experimental stage, but I entertain no doubt that it can be carried out successfully. I was informed that a machine was now being designed for Messrs. Carnegie, Phipps, and Co., of Pittsburgh, for the upsetting of the ends of bridge eye bars as large as 6in. by 1in.

I was shown a number of results of experiments on the strength of electrically welded material. I shall be able shortly, however, to give you the results of tests which are now in progress on the actual welds which were made in my own presence in America, and on this part of the matter I therefore defer further remark. Apart, however, from the strength of the joints made the process has very great advantages in the "cleanness" of the heat, in the rapidity with which it is obtained, in the extraordinary ease with which it can be maintained uniform, increased, diminished, or regulated in any way, and also in the localisation of the heat in those parts of the metal where it is wanted. All these are points of which the immense importance is thoroughly understood by practical men.

Besides these advantages, it is not too much to say that it does easily work, such as the welding of copper and brass, which otherwise could not be done at all, or which, like the welding of hard steel, is exceedingly difficult. At the same time (as I have already pointed out) welds which present special difficulties, on account of section or otherwise, are in many cases carried out just as readily as those of the simplest form.

I have mentioned only incidentally two special points connected with the process which are of importance, the formation of a *burr* or enlargement at the weld, and the advisability of hammering or doing some work on the metal after it is welded. The burr is formed in all cases; and in a great many, although not all, it must be got rid of. At present there are special machines for removing the burr from wire; in other cases it has generally to be ground off. The only hammering which I saw done was done with very light hammers, even in the large sections. In reporting on the strength of the welds which I have brought back with me, I shall be able to say to what extent, if any, this seems to have improved the quality of the weld.

I made enquiries as to the wages paid to the men who worked the welders at the different factories which I visited, and found that in no case had highly-skilled labour been found necessary. At Messrs. Roebling's works only 1.20dols. per day was paid. At other works the rate varied from 1.50dols. to 1.60dols. per day.

I have mentioned, in connection with tube welding, that I saw the process applied to the welding of brass to iron tubes. Other dissimilar metals have been welded (iron, nickel, brass, copper, for instance), but the only other case which I saw used for industrial purposes was the welding of iron shanks to steel tools. I have beside me a number of welds made between wrought-iron and hard steel bar. This process was carried out without any difficulty by properly proportioning the respective distances which the two metals projected from the clamps. I was told that the process had been applied to the welding of lead, and also of cast iron successfully, but these operations I did not see.

In summing up the whole matter, I have to say that the Thomson electric welding process has already, in America, been carried fairly beyond the experimental stage, and has achieved sufficient success in regular commercial work of somewhat varied kinds to warrant the belief that its industrial future is one of the greatest practical importance. I can hardly suppose that any difficulties lie before it, in its future adaptations and applications, so great as those which have already been overcome, not only in the laboratory, but now also in the severer tests of some months of regular practical work.

NEW COMPANIES REGISTERED.

Column Printing Telegraph Company, Limited.—Registered by Rollit and Sons, 12, Mark-lane, E.C., with a capital of £100,000 in £1 shares. Object: to acquire certain patents and rights in relation to printing telegraph machines, in accordance with an agreement, made June 5th, between Alexander M. Aitken, jun., of the one part, and John Gennings, on behalf of the Company, of the other part. The first subscribers are:

	Shares.
J. Moore, 5, New Bridge-street, E.C.	1
W. H. Ashenden, 53, Nunhead-lane, S.E.	1
T. J. Bulling, 49, Penshurst-road, Hackney	1
J. Gennings, 118, Drakefield-road, Nunhead	1
J. Langon, 27, Dalberg-road, Brixton	1
A. Sanderson, 48, Northwood-road, Highgate	1
W. P. T. Forbes, Evergreen Lodge, Wanstead	1

There shall not be less than three nor more than seven Directors. The first are the Right Hon. Earl of Wharncliffe (chairman), Viscount Lymington, M.P., the Hon. A. Brand, W. H. Hurlburt, and Roderick Pryor. Qualification, £200. Remuneration: Chairman, £500; other Directors, £200 each.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The receipts for the week ended June 13 amounted to £4,571.

West India and Panama Telegraph Company.—The receipts for the half-year ended June 15 show an increase of £124 as compared with the corresponding period.

West African Telegraph Company, Limited.—A further dividend of 6s. 6d. per share, making a total of 5 per cent. for the year 1889, is proposed by the Directors of the above Company.

Western and Brazilian Telegraph Company, Limited.—The receipts for the week ended June 13, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,543.

PROVISIONAL PATENTS, 1890.

JUNE 9.

8872. **Improvement in electrical lamp holders.** Frank Suter, 276, Strand, London.

8892. **A new or improved method of insulating electrical conductors and conduits for the same.** Alexander Muirhead and Charles Romley Alder Wright, 9, Warwick-court, High Holborn, London.

JUNE 10.

8933. **Improvements in the method of and apparatus for depositing metals by electro-deposition.** George Henry Felt, 70, Wellington-street, Glasgow. (Complete specification.)

8964. **Improvements in electro motors.** Rankin Kennedy, 10, India-street, Kilmarnock.

8976. **Improvements in and relating to electrically operated musical instruments, and more especially of the piano type.** Joseph Dart Case and Clark Wright Evans, 77, Chancery-lane, London. (Complete specification.)

JUNE 11.

9030. **Primary battery for open circuit work.** Charles Henry Freedman, 276, Strand, London.

9061. **Improvements in electric meters.** Sebastian Ziani de Ferranti and Arthur Wright, 24, Southampton-buildings, London.

9028. **Improvements in arrangements and mechanism for stopping machinery when a thread, or silver, or other material operated upon breaks or becomes absent, or when a given length has passed or a bobbin or spool is full, by means of electricity applicable to machines for preparing and spinning fibrous materials, and to other machinery.** Samuel Herbert Brooks, 45, Southampton-buildings, London. (Paul Clarté, France.)

9060. **Improvements in and apparatus for transmitting and recording orders, specially applicable for use as a ship's telegraph.** Lucien Vialet Chabrand, 46, Lincoln's-inn-fields, London.

JUNE 12.

9101. **An improved form of push switch.** B. Verity and Sons, 31, King-street, Covent Garden, London.

9124. **An electric counter.** Jean Jaques Auguste Aubert, 24, Southampton-buildings, London. (Complete specification.)

9125. **Improvements in telephonic apparatus.** John Edward Kingsbury, 24, Southampton-buildings, London. (The Western Electric Company, United States.)

9130. **Improvements in the means of and apparatus for the regulation of electric currents or their effects.** Charles Richards Heap and Sidney Sharp, 70, Chancery-lane, London.

JUNE 13.

9138. **Apparatus for working electric light arc lamps and other electric appliances by means of twist rod or rods.** Hubert Hallam Bigland and John Burns, 31, Clarence-crescent, Newcastle-on-Tyne.

9163. **An improved automatic electrical switch or cut-out for use in connection with dynamos and accumulators to be charged thereby.** Francis Murray Newton and Tom Hawkins, 46, Lincoln's-inn-fields, London.

9164. **Improvements in electric switch boxes and switches.** Francis Murray Newton and Tom Hawkins, 46, Lincoln's-inn-fields, London.

9165. **Improvements in electrical switches.** Francis Murray Newton and Tom Hawkins, 46, Lincoln's-inn-fields, London.

9166. **Improvements in electric switches.** Francis Murray Newton, 46, Lincoln's-inn-fields, London.

9197. **Improvements in electrical fuses.** Philip Pembroke Alexander, 24, Southampton-buildings, London.

JUNE 14.

9212. **A method of and apparatus for utilising fixed electromotors for elevating, hauling, and other like applications.** John Grice Statter and Sydney Linton Brunton, Norfolk House, Norfolk-street, London.

9227. **Improvements in street and other lamps, also partly applicable to incandescent electric lamps.** Hector Lank, 8, Quality-court, London. (Complete specification.)

9234. **An improved adjustable automatic electric heat signalling apparatus or regulator.** Thomas Evans Mitton, 128, Colmore-row, Birmingham.

9246. **An electro-magnetic separator.** Josef Ronczewski, 433, Strand, London.

9257. **Process for effecting electrolytic deposit of aluminium,** Salo Wohle, 28, Southampton-buildings, London.

SPECIFICATIONS PUBLISHED.

1889.

11328.* **Electric accumulators.** Correns. (Amended specification.) 6d.

11847. **Distributing electrical energy.** Siemens Bros. and Co., Limited. (Siemens and Halske.) 8d.

18897. **Electric switch.** Cunnington. 6d.

1890.

4670. **Electrical heating devices.** Imray (Gilbert). 8d.

5219. **Electric arc lamps.** Andersen. 8d.

6120. **Electrical distribution.** Kintner. 8d.

6121. **Telephonic apparatus.** Lake (Gray and another). 8d.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Anglo-American Brush	—	2¾
— Pref.	—	2¼
India Rubber, Gutta Percha & Telegraph Co.	10	20
House-to-House	4½	5
Metropolitan Electric Supply	—	5¾
London Electric Supply	5	2¾
Swan United	3½	5½
Crompton & Co., Pref.	—	5½
National Telephone	5	5¼
Electric Construction	10	10

NOTES.

Bermuda Cable.—The new cable between Halifax and Bermuda was laid this week.

Conservation of Energy.—Electricity is now utilised in mining coal. And then the coal is utilised in producing electricity.

Coming Events.—The Taunton Gas Company have been obliged to increase their prices by 3d. a 1,000. This will make it all the better for the electric light.

Electric Boats.—We notice that Woodhouse and Rawson United are advertising the supply of electric launches, under the supervision of Mr. W. J. Sargeant, works manager.

Troyes.—A new central alternate current station was opened last week at Troyes, France. The station has been fitted by the Compagnie Nationale d'Electricité. Mr. Ferranti attended the opening ceremony personally.

Gatti's.—We understand that the Strand central station undertaken by Gatti's is proving so profitable that a very respectable dividend is declared. It is intended, we believe, to shortly form the enterprise into a limited company.

Deptford.—We find that the date that the Deptford mains were first tested was given in our article as April 19, instead of, as it should be, May 19. The whole length from Deptford to London will shortly be tested under full pressure.

Electrical Trip.—The electrical trip of the members of the Electrical Trades Section, London Chamber of Commerce, is to take place, Saturday, July 5th, on the electric launches of the General Electric Traction Company, starting from Surbiton.

Gas Destroys Electric Wires.—Leaking gas from a main in Broadway the other week caught fire from a workman's lantern, exploded, and blew up the manholes. The gas main had to be plugged and the gas shut off. The electric wires in the subway adjacent were destroyed.

Gas and Electricity.—At Barmen, in Germany, the electric lighting has produced favourable returns, while at the same time the gas consumption has so greatly increased that a new gasholder, of a capacity of 530,000 cubic feet, is urgently required, and is being got ready for the autumn.

Fire Caused by Electricity.—The mansion of Mr. R. D. Sassoon, at 1, Belgrave-square, W., was the scene of a serious fire this week. The electric light wires caused the ignition of the front room on the second floor, and before the fire could be got under control considerable damage was done.

Curing Toothache by Electricity.—A weak galvanic current, says the *Scientific American*, which will sometimes cure a toothache, may be generated by placing a silver coin on one side of the gum and a piece of zinc on the other. Rinsing the mouth with acidulated water will increase the effect.

Windsor.—The draft provisional order of the Windsor and Eton Electric Light Company, Limited, has been modified so as to meet with the approval of the Windsor Town Council. Under it the Town Council are to have power to purchase the company's property within 21, 28, or 35 years, instead of 42 years.

Westinghouse Tramways.—Lansing, the capital of the State of Michigan, is to have a model electric street railway, which will be constructed by the Westinghouse Electric Railway Company. The Westinghouse people guarantee that the road will be a model to which prospective builders can refer with confidence.

Electricity on the District.—The heads of the agreement have now been approved by the chairman of the Metropolitan District Railway, for the intended introduction of electric traction upon their Hounslow branch, between Acton and Hounslow, and the company's solicitor is now preparing a formal agreement for the approved terms.

Bill Thrown Out.—A select committee of the House of Lords, presided over by Lord Belper, last week threw out the Bill, which had already passed the House of Commons, authorising the Whitehaven Gas Company to considerably extend its limits of supply, to erect works and supply electricity, and to raise £25,000 additional share and loan capital.

American Plants in Australia.—In New South Wales there are now more than 5,000 incandescent and 500 arc lights in use, and it is said that it is a noticeable fact that American plants and systems are predominant. English engineers should see to this. It is their colony and a valuable and ever-increasing field for the supply of electrical apparatus.

Niagara Falls by Electric Light.—One of the features of Niagara during the present season is to be the lighting of the falls by electric light. The Brush Electric Light and Power Co., of Niagara Falls, is putting in a large number of lights in Prospect Park and at various points near the falls. Large reflectors will be used to concentrate the light on the falls.

Edison's Electro-Magnetic Ore Separator.—Reports from Middletown, New Jersey, state that the Edison Contracting Company has equipped fine works for working the new magnetic ore separating process at the Ogden iron mines, has built houses for its workmen, and laid a spur road from the Susquehanna and Western Railroad to the mines. It is said that Mr. S. O. Edison will have charge.

Electric Welding.—The Thomson Electric Welding Company, of America, have just made a contract with the Roebling Manufacturing Company, of Trenton, New Jersey, to supply seven additional welding machines. They have also made contracts with the U.S. Government to install the welding plants at the New York and Norfolk Navy Yards, and with the Pennsylvania Railroad for a large plant at the company's works in West Philadelphia.

Eye Magnet.—In machine shops it is a frequent occurrence that particles of metal penetrate in the skin and eyes. Messrs. Frister and Rossman have, according to *Revue Industrielle*, constructed a magnet for the special purpose of extracting such particles. It is horseshoe-shaped, polished, and nickel-plated ; the two branches are rounded off and end in a point only a few millimetres thick. Its attraction for iron extends for several millimetres.

French Electric Finance.—The Rothschilds are keenly realising the amount of money there is in electrical enterprises, and any undertaking in France has now usually to count upon their word in the matter. The company controlled by them are now actively engaged near the Paris Great Northern terminus in laying mains. The system is also being considerably extended along the Boulevard Sebastopol, and public lamps have been lighted for some considerable time.

Swansea Harbour.—The installation is now complete for lighting the whole of the Swansea Harbour by electricity. The experimental installation simply comprised the Prince of Wales Dock and the pier. The work has been carried out by Mr. Polybank, assistant engineer to the trust. A large engine-house has been erected, and the dynamos are driven by a 250 h.p. to 300 h.p. engine. In the docks there are fixed 25 300-c.p. "Sunbeam" lamps, and in the offices and workshops 10 or 12 500-c.p. lamps.

Thermo-Electricity.—Electricity from heat direct is said to be the subject of a patent by Mr. H. B. Cox, of Maine. Says the Hartford *Courant*, a company has been formed in that city with a capital of 1,000,000dols., and numerous and influential financial firms of the district have been mentioned among its incorporators. The machine is not described, but a furnace, from the glowing coal of which the electricity is led without the intervention of any intricate machinery, is said to be the main feature. Public exhibitions are promised in a few weeks.

Jarman Electric Cars.—It is stated that the London Tramways Company will shortly commence running electric accumulator cars, which will be worked for the company by the Electric Tramcar Syndicate, at a cost not exceeding 4½d. per car mile. The first car will begin passenger service in about a fortnight on the Clapham-Tooting section. The Jarman system is to be employed, the principal feature of which is the employment of a motor having a double armature. On experimental runs a speed of 16 miles an hour has been obtained.

To Supersede the Dynamo.—A Western man, says the *Electrical World*, claims to have discovered a chemical process by which electricity can be generated to the extent of 1,600 volts, and the pressure continuously kept up to that point. He claims that electricity can be produced in this way at a nominal cost, and is confident that his process will supersede the dynamo. Street cars and electric lights are operated at a pressure of about 700 volts, and by means of this new discovery electricity he thinks can be generated on the cars and the overhead wires dispensed with.

Theatre Lighting.—The introduction of the electric light into theatres, thinks the *Gas World*, as a measure of precaution against fire does not seem to have been attended with much success. In 1886 there were 17 theatres burned, in 1887 also 17, in 1888 there were 22, and in 1889 there were 28, of which 15 were burned to the ground. It might be as well to ask before drawing conclusions if the fires occurred in theatres lighted by electricity. That there were more fires from gas in theatres during the last two years does not militate against the use of electricity.

Electric Railways in America.—Chicopee, Mass., is to have electric cars at once. Between it and Holyoke, Mass., 15 miles of electric railway are being laid out. Five other miles will be added eastward this year, and the line will eventually comprise fully 50 miles. At Fort City, Pennsylvania, a line seven miles long will be built. Rockford, Illinois, is adding five miles to its electric railway. The electric railway to be built at Great Falls, Montana, will be extended to the Montana smelter and Giant springs, and it is claimed will then be the longest line in the States.

Fulham.—The Special Committee of the Fulham Guardian Board reported that they were of opinion that it would be advisable in the first instance to obtain some practical advice on the question of electric light, and recommended the Board to give permission to call in a practical electrical engineer at a cost not exceeding 10 guineas, to inspect the premises and to submit a report and rough estimate as to the best and cheapest way by which the proposed adoption of the electric light can be carried out. Captain Berkley moved the adoption of the report. In doing so, he said he agreed with the proposed scheme. This was carried.

Leeds Electric Lighting.—The deputation from the Electric Lighting Committee of the Leeds Corporation visited London last week. Much valuable information has been obtained from the various works in the metropolis, and it is understood that a report will shortly be presented to the full committee, and afterwards to the Council. Among other matters allusion is made to the fact that from Deptford there is now being nightly sent to the West-end of London electric energy for no fewer than 36,000 glow lamps, and that the lighting is very successful, the current being generated at 6,000 volts, and afterwards transformed into 100 volts.

Barnsley.—One of the tenders for the electric lighting of Barnsley has been recommended for adoption by Mr. Bromley Holmes, but before the committee could place the report before the Council it will require further investigation, and they propose to lay it before the Council in about a month's time. As to the contract with the gas company, the committee felt that under the circumstances there was no alternative to accepting their terms. The only alteration was as to the six months' notice. At the present time the Council pay £1,790 a year for gas. Under the new contract they will have to pay £2,081, or nearly £300 a year more.

Woking.—A Vestry meeting was held at Woking last week, to take into consideration the advisability or otherwise of lighting a part of Woking with electricity. A resolution was moved, proposing that electricity be adopted in the station district; and that a rate be made to cover the cost of the same over the entire parish. Tradesmen residing in other parts of the district were not quite satisfied with this arrangement; and an amendment was moved and carried, which, while recognising that an efficient method of lighting should be adopted round the station, pointed to the desirability of the cost being defrayed in that area.

The Electric Lighting of London.—The Board of Trade have, under the powers of the Electric Lighting Acts, granted provisional orders to the House-to-House Electric Light Supply Company for the lighting of a portion of the parish of St. Mary, Lambeth, the parish of Islington, and the district of the Wandsworth Board of Works, comprising the parishes of Wandsworth, Clapham, and Putney. A provisional order has also been granted to the St. James and Pall-mall Electric Light Company for supplying the parish of St. James's, Westminster, and to the London Electrical Supply Corporation for supplying an area comprising the whole of the parish of St. George-the-Martyr, Southwark, together with a portion of the parish of Camberwell.

Government and the Telephone Companies.—In the House of Commons last Thursday week, Sir John Puleston asked the Postmaster-General whether any decision had been arrived at as to the action to be taken in reference to the telephones. Mr. Labouchere also asked whether it was intended to exercise the power reserved to the Government to purchase the undertakings of the National and other telephone companies before the expiration of the first period of their license. Mr. Raikes: In reply to the questions of the hon. members, I have to announce that the Government do not intend to give notice to purchase the undertakings of the telephone companies at the end of the first period of their license—namely, December 31 next.

Electrical Omnibus.—As an appropriate conclusion to the trip of the Lord Mayor to the Electrical Exhibition at Edinburgh, he was met at Euston on his return by the electrical omnibus owned by the Ward Electrical Car Company, Limited, of 38, Gracechurch-street. The omnibus, which was driven by Mr. Radcliffe Ward, the managing director, conveyed his lordship and the town clerk to the Mansion House in a most satisfactory manner, and very quickly, showing itself to be under most perfect control. As we have already stated, the company have in hand a complete line of omnibuses, to run from Charing Cross to King's Cross, with which it is intended to demonstrate commercially the economy, humanity, and cleanliness of electricity over horses, and the facility for locomotion in towns without the aid of tramway lines.

Camberwell.—At the meeting of the Camberwell Vestry last week, the Vestry clerk submitted a report with reference to the provisional order asked for by the London Electric Supply Corporation. It was found that the schedule did not contain Camberwell-green in the area of supply; that it extended down Rye-lane only as far as the railway station; and that Camberwell New-road and Peckham-road had been omitted. Mr. Marsden reported that he had attended at the Board of Trade, and that the following extended area was agreed upon: Rye-lane (to railway station), Camberwell-grove (part of), Denmark-hill (part of), and all roads and streets lying between the railway and Church-street, Peckham-road, High-street, and Queen's-road. The Vestry resolved to consent to the provisional order as amended by the Board of Trade.

Scotch Electric Lighting.—The Electric Lighting Acts Amendment (Scotland) Bill passed through Committee in the House of Commons last week. In the House of Lords on Tuesday, Lord Balfour of Burleigh moved the second reading of the Bill, which was merely intended to amend the schedule of the 1882 Act, and thus to clear up doubts as to who were the local authorities who were to have the control of electric lighting matters in Scotland. The Bill was read a second time. Lord Balfour of Burleigh said that, inasmuch as many towns in Scotland were waiting for this Bill to be passed in order to avail themselves of electric lighting, he hoped that the House would allow the Bill to be committed on Thursday. The Bill was ordered to be considered in Committee of the whole House on Thursday.

Cambridge.—The Cambridge Town Council have appointed Dr. Fleming to advise them on the best mode of procedure in carrying out the electric lighting of the town. Assuming an initial outlay of some £15,000 is in contemplation for the establishment of a station of approximately 3,000 16-c.p. incandescent lamps and 60 1,200-c.p. arcs, Dr. Fleming has undertaken the work of consulting electrical engineer for a sum of £210, this fee to include all the advice needful up to the time of the acceptance of the tenders necessary for the plant for the station. For visits of inspection during the progress of the work, testing, and reports, he is to be remunerated at the rate of £7. 7s. per diem, travelling expenses not included; and for consultations and advice on the extension of the work beyond the above limits at the rate of 2½ per cent. on the proposed additional outlay.

Buns and Electricity.—When we published a note some month or two ago of the shop of Mr. William Beale in the Holloway-road, confectioner and restaurateur, who had erected some electric machinery, and was undertaking the admirable idea of supplying electric light to a few shops around, we were not expecting to hear that this undertaking was to be made the basis of a public company. This, however, is what is being done, and the purchase price of the whole is to be £43,000. Into the bun part of the business we have no wish to enter, but the addition of the electric light installation value £4,350, thrown in, as it were, to help out the scheme, is a sufficiently remarkable way of doing electric light business. The installation has been going a year "without a single hitch," and has five customers. Such little things as parliamentary powers and provisional orders are not, of course, reckoned with in the anticipation of "large and profitable results." It is true that this is the way several well-paying electrical enterprises have developed, but before they have been turned over to any company they have been developed with energy, not simply set up and run (even though without a hitch) content with five customers.

Lighting Canton.—A futile state of things is disclosed with reference to the introduction of the electric light in China. Mr. J. H. Ormerod, an English merchant in Canton, who was recently at the Palmer House, Chicago, thinks that the enterprise will be abandoned. "Several months ago," he explained, "a big syndicate controlling American and English capital started to put in an electric light plant in Canton. The news was heralded over all the world, and many American and Englishmen eagerly took stock in the venture. Not until after the necessary money and the franchises had been obtained did it appear that the scheme would be impracticable. The city of Canton is dead after 7 o'clock in the evening, and only those who have business to attend to are allowed to pass up and down the streets. There is no more need of lighting the streets of Canton at night than there would be of burning the lights here in the afternoon. Then, again, the streets are so narrow that it is with the greatest difficulty that the lines can be put up. But as the work was begun it was deemed best to continue it. A few weeks ago the big boiler came over from San Francisco, and was carted towards the electric light establishment. When about half way to its destination it stuck fast in one of the narrow streets. And there it is now. It can't be moved either way, and a smaller boiler has been sent for."

Electrical Engineers at Edinburgh.—In compliance with the request of a deputation from the executive council of the Edinburgh Electrical Exhibition, an extraordinary general meeting of the Institution will be held at Edinburgh on the 15th, 16th, and 17th July next. Among the papers to be read, in the lecture hall of the exhibition, will be the following: "On some of the chief features of the Exhibition, and mainly of the Electrical Section," by Prof. Robert M. Walmsley, D.Sc., F.C.S., associate. "The Working Efficiency of Secondary Cells," by Prof. W. E. Ayrton, F.R.S., vice-president, C. G. Lamb, B.Sc., E. W. Smith, and M. W. Woods, associates. The executive council of the exhibition have kindly arranged (for members) excursions to the Forth Bridge, and (in electric launches) up the Union Canal. The Great Northern Railway Company will grant to members return tickets, available for eight days, at a single fare and a quarter. (This reduction does not apply to relatives or friends accompanying members.) Negotiations are also being made with the L. and N. W. Ry. Co. for a reduction of fares. The hotel accommodation in Edinburgh is very ample, and the tariffs are about the same as in London. As the final programme depends to a great extent on the numbers who will be present at the meeting, it will be necessary that members should advise the secretary, on or before the 30th inst., of their intention to attend.

Electric Lighting Orders.—In the House of Commons on Tuesday, Mr. O. V. Morgan asked the President of the Board of Trade whether the effect of the provisions which the Board had inserted in electric lighting orders now before Parliament, authorising local authorities to transfer their undertakings, would be practically to confer upon the Board of Trade powers to perform functions heretofore exercised by Parliament, and also deprive the public of the means that they now had of resisting any such transfer by appearing before a Parliamentary Committee where evidence was taken upon oath; and whether the Board would have the power to administer an oath if the functions of Parliament were so vested in that department. Sir M. Hicks-Beach: Section 11 of the Electric Lighting Act, 1882, provides that "no local authority, company, or person shall by any contract or assignment transfer to any other company or person or divest themselves of any legal powers given to them, or any legal liabilities imposed on them by this Act, or by any license, order, or special Act, without the consent of the Board of Trade." The provisional orders granted under the Act referred to require that public notice of the proposed transfer shall be given and the transfer cannot be made without the consent of the Board of Trade, by whom the deed of transfer must be approved, and who will make any enquiries that they may consider necessary in the interests of the public. The Board of Trade would have no power to administer an oath. With regard to the merits of the clause, I wish to point out that the local authorities, who are representatives of the ratepayers, ought to be the best judges of their interests in matters affecting the lighting of the town.

The Laurent-Cely Accumulator.—The special features of the Laurent-Cély accumulator, constructed by the Société Anonyme pour le Travail Electrique des Métaux, consists in the special nature of the lead paste employed, and in the manner in which it is applied to the plates. The active element is a mixture of chloride of lead and chloride of zinc. The fused chloride of lead has a density of 5·6; by incorporating chloride of zinc with it in certain proportions the density is reduced to 4·5. This mixture, brought to a state of fusion, is run into cast-iron moulds in the form of small buttons with rounded edges. After cooling, the buttons are washed to remove the chloride of zinc, and thus to render them somewhat porous. Their density then varies from 4·2 to 3·4. The buttons which serve for the manufacture of the negative plates are then arranged in a metallic mould, into which antimonial lead is run; this surrounds the buttons with a frame which holds them fixed in their positions. The negative plates are mounted in cells filled with acidulated water and provided with zinc electrodes. The composite and zinc plates are then short-circuited. The hydrogen which is disengaged upon the positive electrode reduces the chloride of lead, and there are thus obtained buttons of spongy lead of a density between 2·5 and 3·1, while that of ordinary lead is 11·35. The buttons used in the manufacture of the positive plates are first transformed into spongy lead, then heated in the air to oxidise them, and transformed into spongy litharge. They are fixed, like the negative buttons, in a frame of antimonial lead. The Laurent-Cély accumulator is employed for the lighting of the *wagons lits* on the Chemin de Fer du Nord, and has also served to drive a motor working an electric capstan. This accumulator is the one that was proposed to have been taken up by a large electric traction company in England as part of its system, but the proposal was dropped owing to litigation, and the seizure of accumulators by the French agents of the Faure battery. The Laurent-Cély accumulator, as will be seen, differs from the Faure battery, but we are informed by an electrical engineer who has been investigating the patents that this accumulator seems to be based upon other patent methods, and is hardly entitled to novelty.

Elliott's Smoke Annihilator.—On Wednesday last Mr. S. Elliott, of the Albert Metal Mills, Newbury, invited a number of representatives of the Press to see his smoke annihilator at work at the above mills. Briefly, the machine consists of an iron tank, fitted with a hollow spindle, which connects by a pipe with the chimney whose smoke is to be dealt with. The spindle has a number of holes in it, and is fitted with wings of perforated metal which just dip into the water with which the bottom of the tank is filled. Above it, and resting on ledges, are perforated screens. The spindle is driven by a pulley, and is also fitted with a friction pulley, which actuates another pulley and spindle connected to a fan placed in the chimney communicating with the source of smoke. When started, a damper is shut down in the factory chimney, or other smoke source, and the fan draws the products of combustion down through the hollow revolving spindle, which makes 150 revolutions per minute, whence it escapes by the holes above mentioned, and is whirled round by the wings and mixed with the fine spray which they throw up from the water below. Exhaust steam can be used to keep up the water supply, otherwise a cistern and ball cock are required. The resulting foam lodges on the screens or sieves above, and trickles down into channels, whence it is drawn off by cocks into buckets. The purified smoke escapes by a chimney at the top of the machine in the shape of a greyish and practically odourless vapour. The annihilator takes about 1 h.p. to drive it, but if dealing with boilers above 20 h.p. would be more economical: moreover, Mr. Elliott claims that it economises fuel. The resultant carbonaceous products can be utilised—indeed, have been utilised by the inventor—when mixed with oils and dryers, as paints and primings. When the foam is dried the dust can be used as a fuel, but at present it has not been sufficiently tried to be able to say much on the matter. The machine certainly acts very efficiently, and should enable anyone to comply with the Factory Acts without the least trouble. Mr. Elliott has, we think, displayed a remarkable amount of ingenuity in designing and constructing it. Having seen the machine we had the pleasure of looking round the Albert Moulding Mills, which are admirably fitted up with wood-working machinery by Ransomes, of Chelsea. A large amount of work is being done in mouldings for wires, and, in fact, Mr. Elliott says he will soon have to add to his capacity for turning out these articles if the demand continues to increase at the same rate as during the past year. This is as it should be.

THE EDINBURGH EXHIBITION.—VIII.

At stand 48 the Right Hon. J. H. A. Macdonald, C.B., Lord Justice Clerk, Edinburgh, shows:

(1.) Electric Holophote Course Indicator for the Prevention of Collision at Sea.—This instrument is designed to meet the difficulty which is caused by the great speed of modern steamships—aggravated by many of them being of great length—having a dangerous tendency towards collision. It consists of an electric light, the beam of which is projected by a holophote reflector. This reflector is controlled by the helm, so that its movement, which is done by hand, must necessarily conform to the positions of the helm, thus making it certain that no misleading signal can be given. This is accomplished by setting two pegs, one on each side of the handle of the reflector, by which it is fixed as long as the helm is amidships, so that the light can only shine as a fixed light and straight ahead. But whenever the helm is moved in either direction, an electric circuit round an electromagnet is established, which withdraws one of the pegs, thus freeing the handle on that side. For example, if the helm is starboarded, the peg on the starboard side of the handle is removed, and the reflector can be moved round, so as to give a sweep of the light to the left or port side, being the side to which the starboard helm causes the vessel to turn. The beam of light thus passes over that part of the water through which the vessel is about to pass, giving warning to any other vessel approaching where the dangerous space lies. When the vessel is put upon a port helm, the port peg is removed, and a similar sweep can be made over the starboard side. To give more marked effect to the direction of the sweep, a mechanical arrangement is provided by which, when the light has moved round a certain distance over the water, a screen rises up and shuts out the light from view. The handle is then brought amidships, when the screen at once falls off, and if the helm is still over the sweep can be repeated again and again in the same manner. But whenever the helm is brought amidships the handle is at once locked again, and cannot be moved until the helm is again put over.

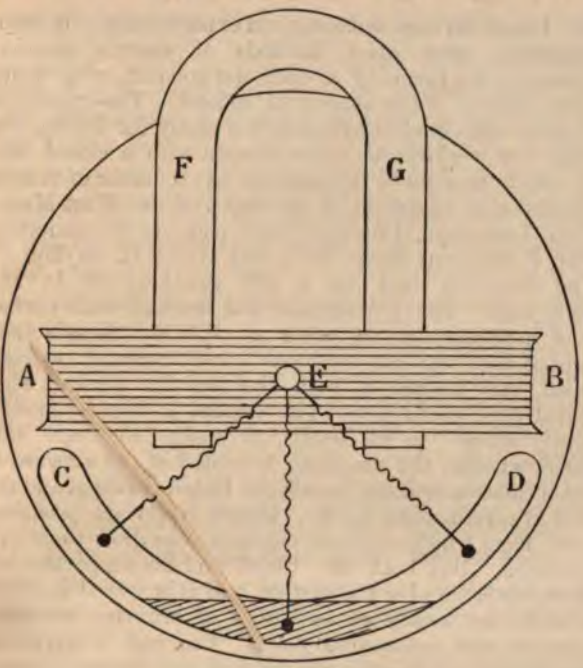

Fig. 1

Tell-tale bells are provided, by which the officer on duty is informed whether the seaman working the light is obeying his orders.

It will be seen that by this means two vessels can inform one another of their courses much sooner than can be done in many cases by the red and green light system, and can instantly inform one another of any change of course.

Awards have been given for this invention by the juries of the Crystal Palace Electrical Exhibition, the Saving of Life Appliances Exhibition, the Inventions Exhibition, and the Edinburgh International Exhibition of 1886.

(2.) Regimental Field Telegraph.—For the purpose of enabling a regiment to carry its own telegraph, two bobbins with double insulated wire are supported on the backs of two bicycles, and six poles for carrying the wires over roads are carried over the handles of the cycles, which are trundled one in front of the other. Special arrangements are made for rapid erection of the poles and rapid coupling of the wires. The bobbins are arranged to be carried on the back for winding and unwinding. The use of bicycles gives a very light draught, and in the event of risk of capture enables the troop, by throwing away the poles, to carry off the wires and instruments by riding.

An award of a silver medal was given to this telegraph when exhibited at the Edinburgh International Exhibition of 1886.

(3.) Barothermotelemeter.—This instrument has been devised jointly by the exhibitor and Mr. Johnston Stephen, of Edinburgh. It is for the purpose of enabling an observer at any convenient place to read off by a single wire the height of the mercury in a barometer and a thermometer, placed at some high or distant station, where the circumstances or grounds of expense make it impossible or inexpedient to have a resident at the station. A barometer and thermometer placed at the distant station can, by a switching arrangement, have an electric current established through the mercury in each of them in succession, and the height of the mercury ascertained in the following manner:

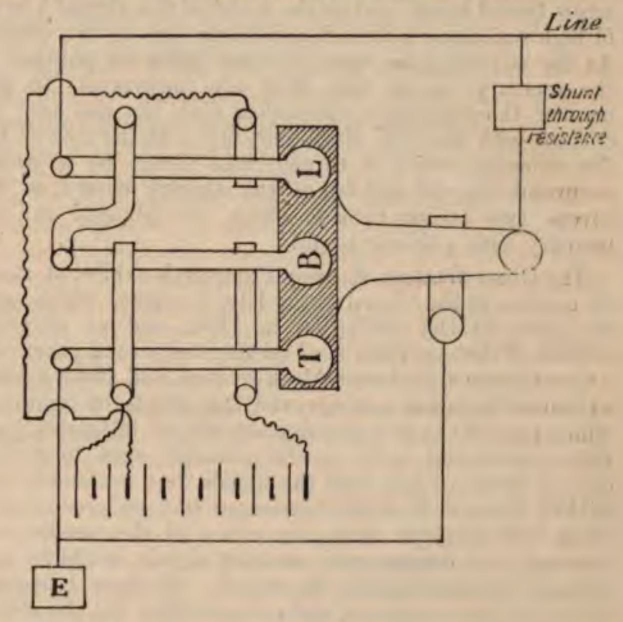

Fig. 2.

The wire carried from the observer's station to the instrument station passes through a switch, which is shown in Fig. 1. A B is a flat coil through which a fixed permanent magnet, F G, passes. The coil is set on a circular disc of ebonite, which is free to move on the axle, E. On the lower part of the ebonite disc is set a curved glass tube, on the lower side of the interior of which a metal plate is placed. From the upper side three wires pass into the tube, one in the middle and one near each end. A quantity of mercury (shown by shading) establishes a connection between the plate at the bottom of the tube and any one of the three wires, according to the position of the coil and disc.

At the observer's station a three-way switch is provided, the arrangement of which is shown in Fig. 2. If the line key labelled L be lowered, a weak current passes to line. This current does not move the disc at the distant station, and the current does not pass through either the barometer or thermometer, but through the line only. But if key labelled B be put down, a strong + current goes to line and causes the coil, A B, Fig. 1, to change its position to the fixed magnet, thus causing the mercury in C D to connect through a different wire, and so switching the current through the barometer. *Vice versâ*, if the key labelled T be lowered, a strong – current causes the coil to change its position in the opposite direction, thus switching the current through the thermometer.

It being thus possible to establish three circuits—one through the line only, one through the line and the barometer, and one through the line and the thermometer—if the resistance of the line be first taken, and the current then passed through the barometer, the resistance ascertained in the barometer connection can be noted. The same can also be ascertained as regards the thermometer. In order to note these resistances, the keys L, B, and T project over a bar made of insulating material (shown by shading in Fig. 1), which is attached to a fourth key. When any of the three small keys is pressed down to its full extent an alternative course is provided for the current through resistance coils, by which the resistances of the circuits can be checked and noted. Accordingly, when the resistance is taken of either of the other circuits, the difference between it and the resistance at last observation can be noted, and if then allowance be made for any difference applicable to the line itself, the correct difference of the instrument circuit can be ascertained.

It only remains to describe how the differences in the instrument circuits are caused by the rise or fall of the mercury in the barometer and thermometer. In the case of the barometer, on the strong + current being sent to line, and the switching disc moved, the current is connected to the mercury in the barometer. In the mercury there rests a rod of insulating material, on which a screw thread is cut, and on the spiral of this thread a wire of high resistance is wound, and forms part of the circuit. As the mercury rises, more of these spirals are plunged in the mercury; as it falls they are uncovered. In this manner the resistance diminishes with the rise and increases with the fall of the mercury. In the case of the thermometer, which is thrown into circuit by a strong – current, the rise and fall of the mercury covers or uncovers two carbon threads which are plunged in the mercury with a similar result.

The Great Western Railway Company's exhibit at stand 53 consists of the "Lord of the Isles" engine, which took the prize at the exhibition in 1851, and an electrical exhibit of the apparatus used on this and several other railways at home and abroad, block system, and also a system of induced coils for getting over the effects of lightning, which previous to this introduction left all telegraph apparatus constructed on the needle principle open to serious danger, as by a slight flash the signals were weakened, by a slightly stronger flash the instrument was rendered useless, by a still stronger flash the action of the needle was reversed, and consequently contrary signals might be sent without the knowledge of the sender. All these difficulties have now been overcome, and not only that, but the saving of labour is great in not having to attend to the instrument so frequently, to say nothing of the inconvenience of the line being disturbed during storms, which is now prevented. It has also increased the strength of the signals to such an extent that the old single-needle instruments can be made into sounders as well as into sight-reading instruments by this induced coil.

There is an apparatus for showing the position of the signal arm on a railway signal when it is worked by a man who cannot see the signal he is working, and shows three positions—the arm at "danger," "off," and any position between these two is shown as "signal wrong."

There is a lamp indicator so that a signalman may know his lamp is burning properly and well, or is out, and his attention is immediately called to it by the ringing of a bell if the lamp is not burning right.

The electric locking system for interlocking the levers working the outdoor signals with the telegraph instruments is shown. By this system the signal is not only under the control of the signalman who works it, but is also controlled by the signalman at the station in advance, and he is again checked by the approaching train itself, so that a signalman cannot lower his signal for another train to depart, by pulling over his lever, until it has been unlocked by the signalman in advance, and when he has once unlocked it for a train to proceed to his station he cannot unlock it for a second train until the first train has arrived at the "clearing point" at his station, so that really the signal is controlled by the two signalmen and the train.

This system is also arranged for single-line working, so that not only cannot one train follow another, but one cannot be sent in the opposite direction until the line is quite clear. There is no mechanical connection between this system and the levers, consequently it can be placed in any convenient position, and is easy adaptable to any system of signalling.

The electric locking apparatus can be attached to any form of block instruments. It does not relieve the signalman of any of his duties or responsibilites: it simply prevents him from giving a wrong signal to the driver either at his own station or the station in the rear.

It is well adapted for junctions and single-line tunnels on double lines of railway, and it can be easily adapted for the protection of shunting in large yards, and is most useful in locking sidings between the station, and drawbridges. Its use is gradually extending, and no doubt in the future will be largely used, as supplying the link required for the present systems, to make them absolutely safe from any incorrect working through misimpressions or forgetfulness of signalmen.

LINEFF CLOSED CONDUIT SYSTEM.

Mr. Lineff has been working and experimenting for some considerable time upon methods of electric traction. Hitherto he has favoured an open-slot conduit, with which he has achieved a fair amount of success. The system, as with most open-conduit systems, was costly for laying, and he has now worked out a new system with a closed conduit, which he showed in operation to a number of visitors on Wednesday afternoon at the depot of the West Metropolitan Tramways, Chiswick High-road, on the invitation of Mr. J. Seymour Keay, M.P., and Mr. E. H. Bayley.

The line was laid for a 100 yards or so in the station yard. The car worked, and worked with perfect ease of manipulation, so much so that Mr. Keay's little daughter ran the car backward and forward, started, stopped, and braked it with the greatest facility when crowded with passengers. The system is simple enough, absurdly simple, in its details, it seems, and one only wonders whether the simplicity is gained at the expense of loss of insulation or other drawback. Detail drawings and the results of careful tests by Mr. Gisbert Kapp are promised shortly, from which electrical engineers can draw their own conclusions. But both Mr. Lineff and his supporters are very enthusiastic over the system, and it is stated that the cost of laying hardly exceeds that of ordinary overhead conductors with ornamental posts. The cost is given at about £1,200 a mile, only one-third of the former system, which would cost £3,500.

The line has a third rail laid beside one of the tramrails, to be 1½in. across. This is of H iron. This rests upon china insulating supports, but not touching the bottom, so that a very shallow trough extends the whole length of the line. In this the copper conductor is first laid, of bare copper. Then comes the feature of the system. A long thin strip of galvanised iron is laid on the bare copper, making contact—not good, perhaps, at any one point, but as it touches the whole length the connection should be excellent. This iron strip being flexible is raised ¼in. or so upwards by the action of a powerful magnet on the car itself, and so makes contact with the conducting rail as the car passes. This magnetic connector is also a feature of the system, and serves both as magnetiser and as connection for the current. Under the car is a thick soft iron bar wound with wire, forming a two-pole magnet. At each end a thick iron wheel forms the pole. These wheels run on the conducting track, tightly magnetised to it, lifts the elastic iron strip underneath, and so receives the main current for the motor. Two indiarubber brushes clear the mud and grit away from the track as it proceeds. The return is made by the rails, and the conducting rail, made in sections, only becomes charged directly underneath the car. The trial was perfectly successful, and the smallness of the cost is evidently greatly in its favour. A length will be put down from Hammersmith to Kew, and negotiations are in progress for lines in Paris and elsewhere.

The trial seemed perfectly successful, and the speed good. A magnetic brake forms part of the system, and stops the car within half its own length. We are informed the car has been run at the rate of 30 miles an hour.

THE PROBLEM OF HEAT CELLS.*

BY ALBERT SCHEIBLE.

After all that has been said by the technical journals against the economy of electric lighting by primary batteries, they are still in the market for this and allied purposes. Where they are used for isolated plants, their costliness is admitted by the users; but at the same time firm after firm has claimed its batteries to compete with steam-dynamo plants. That this claim allures subscribers to primary battery companies, even at this late day, seems to show something more than the survival of old notions among the people at large. This something is the faith of the public in the finding of some readily replaceable and very cheap elements for a battery.

Both the fluid and the so-called "dry" batteries have been brought to a state where they meet the everyday requirements of open and closed circuit work. The length of time during which a battery will give a fairly constant current on a closed circuit has been increased in late years, and is usually greater the more slowly the battery is discharging. Hence, for a long period of constancy the battery must be giving but a fraction of its greatest possible current in a given time. This means that for a given work we may use a large number of cells discharging slowly, or we may use a less number and recharge them more often. Another plan is the use of slow-discharge cells for charging a storage battery, from which the current may then be obtained at a greater rate per time interval than from the primary cells.

In any case we are met not so much with the question of first cost as with that of cheaply recharging the exhausted cells. For storage batteries a dynamo current is used. Some dry cells, such as the Gassner, can likewise be recharged from a dynamo; and as these are slow-discharge cells they may last for many years. The energy of the charging current is that of the coal burnt to produce it, after subtracting the losses in furnace, boiler, pipes, engine, gearing, dynamo, and wire. Ordinarily, 4 per cent. of the energy of the coal converted into electrical energy may not be a low estimate. This means that any other means of restoring the energy in a battery at 25 times the cost of energy in coal is as economical as the use of a charging current, other things being equal.

With primary batteries the efficiency—*i.e.*, the energy furnished as current, in terms of that in the materials consumed—is much higher than the efficiency of a steam-dynamo plant. At first thought the electrical energy would be taken as equal to that of the heat of combination of the elements. But F. Braun, Czapski, Gochel, and Jahn have shown that the relation between the two depends on the individual processes in the cell. A given process may, under varying circumstances, while causing the same heat of formation, produce different E.M.F.'s. It is true that for many of the common reactions the electrical energy produced is practically equal to that of the heat of combination, and may be calculated accordingly. But, as the above-mentioned German physicists have shown, this equality is not a general one, as Julius Thomsen and others held it to be. Hence the theoretical efficiency of conversion is not in every case 100 per cent, though it may be very nearly as high. In calculating the working efficiency, as defined above, the known energy of combination of the materials consumed forms the starting point. W. Peukert found the efficiency of the Daniell cell to be 47·7 per cent., that of a Bunsen, 59·1 per cent. F. B. Crocker found a bichromate battery solution to have 45 per cent. efficiency, and thought that of a copper sulphate solution might be 80-90 per cent. His paper before the American Institute of Electrical Engineers two years ago showed the possibilities of galvanic batteries, and the expense limit of cells as built at present. It emphasised the high efficiency of batteries as means of converting chemical into electrical energy, holding that 75 per cent. could easily be reached. Such figures would place the battery equal to the dynamo plant, if costing 10 or 15 times as much. But at present electric lighting from batteries costs 50 cents per horse-power hour, against 2 cents for that from steam dynamos, or 25 times as much.

What makes the primary battery lighting so expensive is that recharging means renewing costly elements, a partial repetition of the first cost. The steam-dynamo plant may be wasteful of the energy in the coal, and hence in theory an expensive means of charging batteries; but it builds up the chemical separation in the elements as found in the exhausted cell. No new elements are needed, nothing but the energy of the current. The elements of the battery may well be costly, if its energy can be cheaply restored to it. Now, if the energy of the charging current is obtained at such a loss from that of the coal, why not use the energy of the coal directly? In other words, why not have the chemical separation in the cells produced by the application of heat to the exhausted cell? The possibilities of such a heat cell, or "thermo-chemical battery," may have been dreamt of by many, though almost nothing has been published on the subject. Two years ago I wrestled with this problem, and as little seems to have been done since then toward solving it, it may be well for me to show what it implies.

The great requirement for a heat cell is a chemical action readily and perfectly reversible by heat. Since gases are very poor conductors, this reaction must take place in the wet—*i.e.*, either in solution or in presence of a conducting liquid. Then, too, the element which is to form the attacked electrode must preferably be a solid; although a liquid, separated from the solution either by the difference in their specific gravities or by a porous partition, would do. Such a reaction would probably meet the case. In looking for it whole classes of salts may be excluded for their known common properties, thus narrowing the search. Reversible reactions are not uncommon, but I found few which, on good authority, meet the other conditions mentioned above. Experiments with these few gave negative results, for reasons which, while more or less apparent, were not in the works on chemistry referred to. My work was confined to the more accessible inorganic salts, leaving both the rarer ones, and all organic compounds which may promise some fruits yet.

Mr. W. E. Case in his heat cell follows a different plan, the heat causing the reaction which produces the current. The double reactions applied in this cell were discovered by Sir Henri Loewel. They are the precipitation of metallic tin from a solution of $SnCl_2$ by $CrCl_2$, and the redissolving of the metal with formation of the original salts when the solution is heated to 140deg. F. Here the current flows during the short time while the first-named reaction is brought about by the heating. While the cell is cooling there is probably a current generated by the combination of the CrCl with 2Cl, but as the former is in solution, and thus in contact with the carbon electrode, this current cannot be utilised. But as this current still corresponds to a certain amount of heat applied to the battery, the theoretical efficiency of the cell would, in all probability, be much lower than that calculated by Mr. Case. Neglecting this probable great loss, as well as others due to radiation and local currents, we can look at the battery as a heat engine. As such its efficiency is $E = \frac{T - t}{T}$ where T is the higher and t the lower temperature limit, both reckoned from the absolute zero of temperature. This for a range of 80deg. to 180deg. F. gives 15·7 per cent., a very promising figure.

While several chemical thermopiles have been described in the electrical papers, this is the only true heat cell that I have noticed, and I think on the lines suggested would be more nearly ideal. If it has a greater temperature range it will have a still higher theoretical efficiency than the 15 per cent. just given. Even a rough approach to this in practice would make the heat cell as economical as a steam-dynamo plant. Its other advantages for small "household" plants will suggest themselves. With the rapid unfolding of chemistry in its electrical phases, may not such a heat cell be looked for?

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THE REIGN OF TERROR IN PATENT MATTERS.

The lawyers and scientific experts in patent cases are likely to have a busy time shortly. No less than three patents, all of them of a so-called fundamental character, will in the near future occupy the attention of legal authorities, when an attempt will be made to galvanise them into life after a lapse of many years. These are the Edison feeder patent, the Hopkinson patent for transformers, and the Lane Fox patents. If rumour is to be credited, it would seem that an appeal to the House of Lords in the case of Ferranti *v.* Gaulard and Gibbs is also on the cards, and that the Edison-Swan Company intend to enforce the rights which they suppose they enjoy in the use of a spring attachment to lampholders and of fusible plugs. If all these matters should come into court, the crop of litigation will be truly a formidable one, and seriously hamper the development of electrical engineering, which, fortunately for all concerned, has now taken so favourable a turn. Confining our attention to the three first-named patents, we find that they are not of equal immediate danger to the industry. The feeder patent has already once been amended, but its owners evidently think that it can be made a more handy fighting weapon by a further amendment, and have accordingly applied for leave to make the amendment. The transformer patent is also under notice of amendment. It is almost certain that in both cases powerful firms and companies will oppose the amendments, and even if unsuccessful in their opposition, will resist the demands which the owners of the amended patents will make upon them. The danger which threatens to the electrical industries from these two patents is therefore not an immediate one, and will in any case not be a very serious one, since, by the very nature of the claims in these patents, the attack must be directed against supply companies as distinguished from small manufacturers, contractors, or owners of private installations, and these companies are generally large and powerful organisations who do not lack the sinews of war which are necessary to test a disputed right at law. In such cases we may be pretty certain that he who has right on his side will win the day.

With the Lane Fox patents the outlook is of quite a different character. We have already, in a former issue, commented on what then appeared probable that the Lane Fox Company would do, and we concluded our article with the remark that we would return to the subject when the intentions of the company were made known. This has now been done, and we find that the outlook is not very cheering, and that the Lane Fox patents are in a totally different position from the other two patents to which we have alluded above. In the first place, no amendment preliminary to taking action is proposed to be made. In two amendments the original distribution patent has been whittled down to a mere shadow of its former self, and nothing but a broad claim now remains for the use, in combination with a distributing system, of secondary batteries as reservoirs of electricity. If this claim could be upheld the owners of small private installations, in which storage batteries are almost invariably used, would be the persons liable to pay the Lane Fox Company a royalty. But it appears that this company does not wish to confine its operations to so small a sphere, for a circular, offering terms of licenses, has been sent round to all the large manufacturing firms, contractors, and supply companies, irrespective of the fact whether or not they use secondary batteries "as reservoirs of electricity." The opening paragraph of this circular is so unique in its tone of assurance that it merits being quoted verbatim. It runs as follows: "You are doubtless aware that your company is making use of the Lane Fox patents for electrical distribution, No. 3,988** of 1878." Obviously, such a statement sown broadcast throughout the industry is only justifiable if the owners of the Lane Fox patents are convinced that the remaining and only claim in the patent cited covers electrical distribution generally. But can this possibly be the case? Let anyone take up the patent specification 3,988 of 1878 and its two amendments, and after careful perusal say what is the essence of the invention disclosed. If we mistake not, he will come to the conclusion that the use of an earth return and, in combination with it, the storage in secondary batteries were considered by Mr. Lane Fox the great features of his invention in so far as it related to distribution. It is idle to argue now that the term "earth" meant any conductor, and therefore an insulated conductor amongst others. Unfortunately for Mr. Lane Fox, such an interpretation is contradicted by his own specification where he says that gas or water pipes may conveniently be used to effect the connection to earth. If earth meant an insulated cable, would any engineer in his senses make connection between it and the lamps by means of gas and water pipes? In a subsequent patent (taken out in 1883), Mr. Lane Fox makes a clear distinction between earth and metallic return, and this circumstance alone seems fatal to the favourable interpretation of the famous earth return which the owners of the patent now try to read into it.

But it may be asked, if all this is so clear, how comes it that so many eminent men have reported favourably on this patent? Our answer is that these men have merely said that instead of earth a metallic return may be used, which is a very different thing from saying that Lane Fox has an exclusive right to the use of a metallic return. With all due deference to the opinions given by the leaders in science, we do not think that the Lane Fox Company will find it an easy task to convince the large electricity supply companies that they ought to pay royalty under this patent, and we doubt very much whether an attempt to convince them by legal means will ever be made.

There seems, however, to be some prospect that smaller firms and men will be attacked. On the 18th inst., the secretary to the Lane Fox Company sent circulars to the owners of private installations, in which he offered to grant them licenses varying from 1s. 6d. to 2s. 6d. per lamp per annum, stating that the Lane Fox system is for "multiple arc distribution of incandescent lamps; constant pressure being maintained in the conducting mains, and secondary batteries being used as reservoirs of electrical energy." We can well imagine that the owner of a small private installation will prefer to pay the few pounds demanded by the company to the risk of finding himself involved in an action for infringement, and that a private person about to put down an electric light plant in his own house might be frightened out of his intention by the threat conveyed in Mr. Stephenson's circular. Such a person would naturally think that if this particular company can demand royalties to-day, another company may demand royalties for some other patent to-morrow, and so on; to avoid which he would rather dispense with the electric light altogether. Herein lies the real danger to the electric lighting industries. We have no wish to prejudge any possible rights the Lane Fox Company may have, and in the interests of electrical engineers generally we consider it essential that the question be tested at law. But let the fight be a fair one between opponents equally matched as regards financial resources. We hear that Mr. Lane Fox has convened a meeting of electric light contractors for Tuesday next, to discuss the question of royalties "in a friendly spirit." There is only one way in which he can show this friendly spirit—namely, by letting the small men alone until he has established his rights against one of the large supply companies in a court of law. If he will not do this, then the small men must combine and elect one of their number to fight a test case. To adopt a middle course, such as the payment of a merely nominal royalty, would be unsatisfactory to all parties. Either the Lane Fox Company have a right to control electric distribution, or they have not. If they have the right, then it is only just to them that this right should be acknowledged by the whole trade in the way in which such rights are always acknowledged—namely, by the payment of a reasonable royalty. If they have no right, then even a nominal royalty is unjustifiable.

PUBLIC LIGHTING OF BATH.

Mr. Massingham had a thorough and well-deserved success on Tuesday night when the public lighting of the fine old town of Bath was turned on by the Mayor. Mr. Massingham has had a long and sometimes fierce struggle to carry through this scheme for the beautifying of Bath, and backed up by Alderman Sturges he has, in spite of the opposition of the gas company and its supporters, who are strong upon the Council, gallantly carried his installation to a success which cannot but largely influence the future of electric lighting in the West of England.

At eight o'clock in the evening the electric light works presented an animated and busy scene. Considerable numbers of Bath's prominent citizens were assembled inspecting the machinery, which was already in motion waiting for the final connection by the Mayor. The mayor (Alderman Bartrum), decorated in his official crimson collar, inspected the plant and had the working explained. Outside the roadway was crowded with sightseers, waiting both for the lighting up of the public lights and the exit of the Mayor and citizens. Exactly on the stroke of nine the Mayor pressed the button, circuit was made, and the lamps throughout the whole city sprang into brilliancy as the crowd cheered.

The Mayor then stepped into the yard and said that, simple as the operation he had just performed appeared, it was really the culmination of a complicated arrangement, an illustration of the vast triumph of man over the forces of nature. It might be supposed that there was rivalry between the gas and electric light, but it was one of how best to supply the public wants, and that which best did this would obtain and retain the support of the public. There was, in reality, he thought, no rivalry, because there was no limit to the usefulness of each. Bath now contained the largest installation of public lighting in England, and as people had once gone to Taunton they would now visit Bath to see a model installation. The success was due to Mr. Massingham, who had come unknown, and had overcome obstacles which one with less determination and tenacity would have found insuperable. It was due to Mr. Massingham to credit him with the success. Mr. Massingham returned thanks to the Mayor in a few appropriate words.

An informal procession was then made throughout the town. As yet the light was too bright for the lamps to show up, as the night was very fine, but as the sunset faded the fine old façades and crescents of Bath stood out in the brilliant radiance, and everyone acknowledged that the lighting of the streets was a very great success The lamps are Thomson-Houston 1,200-c.p. lamps, mounted on tall ornamental posts on the sidewalks about every 100 yards, and are surmounted with reflectors. The lampposts have been very carefully arranged to get the best effect, and the streets are well and thoroughly lighted. The contrast between the few short streets still lit with three dingy gas lamps and longer streets fully illuminated with two arcs is very striking.

Forty miles of underground mains have been laid by the Callender Company, under the supervision of Mr. Reid, and 59 streets have been lighted. The contract taken by Mr. Massingham is to last for seven years, at the rate of £2,100 per annum. The machinery in the central station comprises four 35 h.p. vertical engines, each driving a 50-light Thomson-Houston dynamo for the public lighting, and two 150 h.p. engines driving Mordey alternators supplied by the Brush Company, each capable of supplying 4,000 10-c.p. lamps for private lighting. Other machinery will be put down in September, and the station, when complete, will be capable of supplying 300 arcs and 30,000 10-c.p. incandescent lamps.

Subsequently, Mr. Massingham entertained a large company at supper at the Grand Pump Room Hotel, General Burns presiding. The Mayor was unable to attend. After the loyal toasts,

Mr. J. E. Sturges proposed "Success to the Electric Light, and the Health of Mr. Massingham." He said he had never wavered in his advocacy of the electric light, and he was gratified at the success he had predicted for it. They owed a debt of gratitude to Mr. Massingham, who was especially suited to the work, and a man of scientific knowledge and great perseverance. Bath had shown an example to Bristol, and its citizens should be proud of what they had done.

Mr. Massingham, in reply, acknowledged the ability of his electrician, Mr. Hooker, and mentioning the perfection to which the light had been brought, said it had been switched from one dynamo to the other without anyone noticing it.

Mr. J. W. Morris, in a brilliant and patriotic speech, proposed "Prosperity to the City," and Mr. J. Chivers responded.

General Burns proposed the "Visitors," to which responded Mr. T. Callender, who objected to being called a visitor, as he had pulled up all their streets and laid the mains; he considered that Bath—which depended on its beauties—could not exist without the light. To the same toast responded Mr. Williams, of Taunton, who said that Bath, like Cranmer, had lighted such a light as should never be put out.

The evening closed with many sincere wishes to Mr. Massingham for future prosperity; and a midnight inspection showed the beauty and full success of the light.

DOES EARTHING THE SECONDARY CIRCUIT OF A TRANSFORMER PROTECT THE CONSUMER?

BY SYDNEY F. WALKER.

In the writer's opinion it does not. In fact, if the arguments which follow are correct, it would even appear that the earth connection, so far from being a protection, is, under certain conditions, a source of danger; and the object of the present article is to remove what is believed to be an erroneous impression on the subject.

The weak point of the high-tension transformer system is, of course, the possibility of a connection being made between the high-tension primary and the low-tension secondary circuits, leading to danger from fire and probable danger from shock. To prevent this, fuses are inserted in both primary mains on their way to the transformer, and in both secondary mains immediately on the consumer's side of the transformer. If these fuses act, either the primary or the secondary, well and good, but it has been justly urged fuses sometimes fail. It is necessary that they shall be of such strength that any ordinary variation in the E.M.F. of supply shall not destroy them. It would be intolerable if all the lights in an establishment were extinguished, for instance, if a number of lamps were suddenly turned out in the district. And if the fuses are not to require rather frequent attention, they must have a margin of strength over and above this also, to provide for oxidation, the brittleness created by the passage of the current, and other contingencies.

Then the other factors come in. The fuses may be in a position where the surrounding atmosphere is sometimes hot and sometimes cold; and at the moment when they are required they may be surrounded by cold air, perhaps in a keen, biting draught from an east wind, and they do not act.

Further, the transformers now in use are apparently well made and highly insulated, because their manufacture is in the hands of a few well-known firms who are able to obtain a price that will pay for good insulation and plenty of it. But the time will come when competition will be keen if transformers are much used, and then will come the question, how can money be saved in construction? If the manufacturer has before him the fact that a defect in the insulation of the transformer may lead to the loss of human life, he will in most cases see that it is perfect, so far as he knows how. But if this fear is removed, if there is the feeling that the earth connection will put all right in the last resort if the fuses should fail; then there may be a temptation to cut the insulation as fine as possible so long as it passes the supply or insurance company's test, and not to remake an apparatus when a workman has made a slip.

It is in these very cases, as will be shown later on, that the earth connection produces danger instead of making up for structural defects.

Consider the two phases of the danger separately: first, the danger from overheating the wires within the house, and secondly, the danger to life. In order that there may be overheating in the consumer's wires, it is necessary that some portion of these wires, or of the secondary coils of the transformer, should form a part of a circuit in which the primary E.M.F. is included. This is not possible with only one connection between the primary and secondary circuits, unless the latter is connected to earth. If there is only one connection between the two circuits and no connection to earth anywhere, either on the primary or secondary circuits, no harm is done, as there is no path for the primary current except its own legitimate one. But there is always a connection to earth on the primary circuit, though it may be of high resistance; because, if no other connection exists, there is one through the dynamo itself; as it has been found impossible, so far, to insulate the coils of the dynamo from the framework of the machine, and therefore from earth, to any high degree for high-tension currents. Therefore one connection between primary and secondary produces danger of fire if there be an earth connection on the side of the secondary, and it will be evident that the danger will be inversely proportionate to the joint resistance of the connection between the primary and secondary circuits, the earth's connections of primary and secondary, and that of the path by earth itself; and the more any one of these is lowered, the greater chance is there of danger, provided the main primary fuse does not act. Two points in connection with this matter should be considered, however. First, it is by no means easy to obtain a good earth connection either for the secondary circuit or for any screen that may be interposed between the primary and secondary coils of the transformer. It must be remembered that for *earth* to be effectual, its resistance must bear some proportion to that of the rest of the circuit. What is good earth for a telephone line may be very bad earth for an electric light system. It must be remembered, too, that the resistance of the earth circuit consists, not only of that of the connections to it, external to itself, but of the path through the earth's crust, and very often this latter is very high. As telephone engineers know to their cost, earth connections are often very troublesome, even for the small currents they use, owing to their high resistance in comparison with that of the telephone lines; and even allowing for the greater sensitiveness of telephone apparatus, and the greater liability to trouble from that cause, it is evident that the chances of obtaining an earth circuit for electric light currents that will really be of any value, must be a work of considerable difficulty. A total earth resistance, for instance, of 10 ohms would be nothing out of the way in a telephone or telegraph circuit, especially on long lines; but such a resistance upon an electric light circuit would be enormous; and yet the same appliances have to answer in each case.

It is possible, of course, to arrange a so-called earth circuit that will answer. In fact, electric light circuits using earth as a return are established facts; but *earth* in these cases does not mean earth in the ordinary sense of the term. It is not the *ground* of our American friends. It is a mass of metal—such as the skin of a ship, plus the water it floats in; or a lot of iron rails or pipes, carefully jointed with copper wires, and with all doubtful places bridged over. This is an uninsulated metallic return, not the *earth* that is to be provided in connection with transformer systems of supply.

And, secondly, it should be remembered that the creation of a path for the current to earth on the consumer's side of the transformer tends to break down the insulation between the primary and secondary wires, the very thing which it is so important should be maintained as high as possible, and the time occupied in breaking down the insulation will be directly in proportion, other things being the same, to the resistance of the earth circuit. The lower this is the more rapid must be the deterioration. It is well known, of course, that the passage of a current through insulating material alters the nature of the latter, tending to lower its resistance, and in the end breaks it down altogether at some favourable point, say by sparking across.

The higher the initial resistance the smaller the current strength that passes, and the greater the length of time that will elapse before the resistance of the insulation will be appreciably deteriorated; but it must be the initial resistance of the whole circuit in which the insulation is included.

Earthing the screen, which in some transformers is placed between the primary and secondary, protects the insulation between the secondary and the screen from this deteriorating influence, providing there is no connection to earth on the secondary circuit itself, and is, therefore, an additional protection against fire. But here comes in the question once more, what is earth? In most cases there will be a connection, though of high resistance, between the secondary and *ground*, and, of course, between *ground* and whatever is used for the earth connection to the screen, so that a small current will be passing through the insulation of the primary circuit as well, tending to break it down as the other.

Next, consider the more important question of danger to life from shock. It is stated that if the fuses fail to cut off the consumer from the high-tension primary circuit, still the earth connection will protect him should there be a connection between primary and secondary. In order that the consumer may be protected, the E.M.F. between the metallic portion of his circuit which he is able to touch, say, some part of the lamp fitting, and the ground he stands on, must be reduced below the dangerous point, say, to 200 volts. Unless this is done, the earth connection does not protect him. He is in one derived circuit between the supply wires and ground; the protecting earth connection is another; and the current passing through the body, when it forms a branch circuit between the supply wires and ground, will only be affected by the connection to earth, if the latter is able to provide a path of such low resistance for the primary current, that the current which passes along the primary wire reduces the E.M.F. beyond the contact between primary and secondary to 200 volts, or less, in accordance with Ohm's law.

Of course, long before such a current did pass, the primary fuses should have melted; but supposing they did not, and it is this supposition the earth connection is to provide for.

Now, consider what probability there is of the earth connection providing such a path for the primary current.

Take the primary E.M.F. at 2,000 volts, and the limiting E.M.F. for the safety of the consumer at 200 volts, we have 1,800 volts to dispose of; what current and what earth resistance will effect this? Take the resistance of one primary main from the dynamo to the transformer where the contact exists, and including that of the contact at 1 ohm. In order that the E.M.F. may be reduced to 200 volts at the point of contact, the current passing C must equal $\frac{E}{R} = \frac{1,800}{1} = 1,800$ amperes.

But this current must pass in the whole circuit, including the dynamo itself, the contact to earth; whatever it may be, on the primary circuit; the primary main before referred to, the contact between it and the secondary, or with the screen between primary and secondary, the connection to earth, and the path *by earth* back to the dynamo. In order that the voltage at or beyond the point of contact may be only 200 volts, the resistance of all these must be inappreciable. Take the primary voltage at the dynamo as 2,000 volts, as before. Then R, the resistance that must rule in order that 1,800 amperes may pass, must equal $\frac{E}{C} = \frac{2,000}{1,800} = 1$.

But we have already taken the joint resistance of the primary main and the fault at 1 ohm; therefore the resistance of the rest of this circuit must be only ·1 ohm; which, as every electrical engineer knows who has experience with earth circuits, is an absolute impossibility.

It may be objected that the resistance of the primary main would be less than the figure that has been given, but a glance at the formula will show that this only increases the difficulty. On the other hand, the resistance of the primary main, plus that of the contact, might be greater than 1 ohm, and therein lies safety as far as it is to be obtained; since the higher this resistance the smaller the current required to reduce the E.M.F. to a safe voltage, and the greater the margin for resistance of the earth circuit. With 2 ohms for resistance the earth may have ·2 instead of ·1, with 4 ohms it may be ·4, and so on.

The fact that other transformers are being supplied from the same primary mains will hardly affect the issue, as the current passing in all the transformers is necessarily, from the nature of the system of distribution, very small in comparison with that required to reduce the voltage to the safe limit.

Further, it will be noted that in those cases where the insulation between the primary and secondary wires of the transformer is weak the current passing through it will be stronger than where the insulation is high, and will therefore deteriorate more rapidly.

THE WEYMERSCH PRIMARY BATTERY.

The following report upon the Weymersch battery has been made by Messrs. Alabaster, Gatehouse, and Co., with special regard to cost and working of the battery under ordinary conditions of working:

THE WEYMERSCH BATTERY SYNDICATE.

The Weymersch Primary Battery.

Gentlemen,—In accordance with your instructions we have made some practical tests with the Weymersch primary battery, and we now submit to you the results we obtained. Prior to entering into the details of these trials we desire to call attention to our former experiments made in the month of June, 1888, in which a five-cell battery was kept continuously at work for 31½ hours, giving a current of 10 to 10·6 amperes. The free potential of the cells varied only about 3 per cent., and the working E.M.F. was practically the same at the end of the run as at its commencement; the consumption of zinc, moreover, was only 10 per cent. in excess of that indicated by theory. We were thus enabled to report that, in our opinion, Mr. Weymersch's battery was a great advance on any galvanic elements previously employed for the generation of comparatively heavy currents.

The Weymersch cell is of the double-fluid type, the electrodes being zinc and carbon, with an exciting solution of dilute sulphuric acid, and a depolarising solution containing several well-known ingredients, the proportions and preparation of which the inventor keeps to himself. The respective liquids are separated by a porous pot or plate, according to the mechanical construction of the battery.

The main differences between the conditions of 1888 and those of the present date consist in the diminished size of the cells, the substitution of porous plates for pots, and some slight variation in the strengths of the exciting and depolarising solutions.

The batteries as recently submitted to us consisted of wooden boxes each containing six cells with double zinc and single carbon plates. Seven of these were connected up in series, thus making a battery of 42 cells. After some preliminary trials extending over several days with both arc and incandescent lamps we obtained the results which, in tabulated form, are attached. We here desire to remark that we should not expect to get in other sets of batteries precisely similar figures, as the latter greatly depend upon the nature and porosity of the porous diaphragms, which, as all users of batteries are well aware, are usually found to be variable in their character.

The external dimensions of each box are as follows: length = 3ft., including taps, etc., width = 9in., depth = 16in. over all, including covers. The inventor only guarantees his battery to run for 18 hours with one charge of depolariser, but it will be seen that there was but little change in the electrical constants of Table I. at the end of a 24 hours' run, so that the guarantee is within very safe limits. The arc lamp circuit, moreover, was kept running even longer (30 hours) with one charge of depolariser.

The measuring apparatus used by us in the trial runs were kindly lent to us by the General Electric Company, Messrs. Siemens Bros., Messrs. Paterson and Cooper, the Planet Electrical Engineering Company, and Mr. A. R. Margary, who assisted us throughout; and we desire here to place on record our appreciation of the excellence of the various voltmeters and ampere-meters supplied to us and the close agreement of their indications, which showed very careful calibration.

Finally, however, to measure differences of potential we selected a Siemens potential galvanometer and a Cardew voltmeter. The readings of these two instruments were to all intents and purposes identical, as may be seen by the following comparison:

Siemens 54·325 volts, 74·82 volts.
Cardew 54·33 „ 74·6 „

As the current measurer we employed on the circuit of incandescent lamps a newly calibrated Siemens electro-dynamometer, and on the arc light circuit Miller's patent ampere-meter.

The conditions under which the tests took place were as follows:

For the incandescent lamps there were used 42 cells, and for the arc light 36. The daily run, to represent as nearly as possible what would probably occur in actual domestic use with glow lamps, was of six hours' duration. At the end of each run the exciting solution was drawn off and renewed on the following day prior to the battery being put in action. For the first 12 hours the exciting solution was at the density of 7deg. Beaume, and at a temperature of 62deg. F.; for the next 12 hours the acidulated water was strengthened to 10deg. Beaume. On the fifth day the depolariser showed signs at the beginning of the run of becoming exhausted, so the experiment was stopped.

Although the depolariser was unchanged throughout the experiment and not emptied from the cells at night, it is necessary to say that, owing to a certain degree of leakage through the porous plates, a small quantity of fresh liquid had to be added each morning to bring up the level again.

The zinc plates, 7⅛in. wide, were immersed to a depth of 7⅜in., and the total weight of the 84 plates amounted to 280lb. 4½oz. When weighed after the trial the result showed that 176,190 grains of zinc had been consumed, or 28 per cent. in excess of that theoretically necessary to produce the same electrical energy—viz., 9,477 watts.

We find that the cost of materials alone (taken, with the exception of the depolariser, at their market values), leaving out of consideration depreciation, cost of maintenance, labour, etc., to produce one unit of electrical energy (1,000 watt-hours) amounts to 2·13 shillings if the depolariser is charged for at 9d. per gallon. If, however, this is taken at its actual cost price, the cost per unit is then reduced to 1s. 6d.

Putting this result in another way, and taking a good 16-c.p. incandescent lamp as requiring 50 watts to heat it to that luminosity, we find that the cost per hour (for materials) to keep such a lamp in action is, in the one case, 1·275d., and in the second 0·9d. A slight reduction in the prices of materials, which would probably result from buying them in larger quantities, would practically mean that a 10-c.p. lamp, a convenient standard for comparison, would cost (for materials) actually ½d. per hour.

To arrive at the cost per unit, including consumption of material, labour, depreciation, cost of maintenance, etc., would necessitate a series of renewal tests lasting over a lengthened period, so we purposely avoid all reference to expense other than that of material used up, for the simple reason that the batteries will be sold outright, just in the same manner as a shopkeeper would sell an oil lamp, the buyer placing it under the control of his servants, and the operations connected with its use coming within their daily duties. Naturally the manipulation of a primary battery varies with the nature of the person employed to look after it, and from other causes, and while in one instance it may cause but little trouble, in another case the attendant difficulties may be considerably increased.

It might, perhaps, be urged that the user of a primary battery will not reap the advantage of all his outlay on materials consumed, as he cannot leave the zincs in position until the metal has been all dissolved; but this objection is met by an arrangement by which the consumer is supplied with an equivalent weight to that unconsumed of new zinc, so that in reality he loses nothing in the shape of waste material. The circumstances under which the arc circuit was run were slightly different to those of the other tests

TABLE I.—Incandescent Circuit.

Date. 1890.	Time.	Duration in hours.	Current (c) amperes	E.M.F. volts.		Resistance of battery. Ohms.	C.E.T. external circuit. Watt-hours.		Theoretical weight of zinc consumed with average current per cell.	Actual weight of zinc dissolved in grains per cell.	Difference between theoretical and actual consumption. Per cent.	Exciting solution in quarts, 7deg. Beaume.	Depolariser, in quarts.	Temperature of solution. Fahr.
				Open.	Closed		Actual.	Average						
May 19..	11·0		7·164	84·05	53·30	4·30	381·8	...	...	...	...	84	44	...
	12.0		7·240	77·90	55·00	3·16	398·2	390·0	134·8	...	...	...	...	...
	1.0		7·240	77·90	55·00	3·16	398·2	398·2	135·5	...	...	...	...	...
	2.0		7·164	76·50	54·84	3·02	392·8	395·5	134·8	...	...	...	...	...
	3.0		7·087	76·00	54·80	2·99	388·3	390·5	133·3	...	...	...	...	...
	4.0		7·010	75·85	53·80	3·15	377·2	382·7	131·9	...	...	...	...	...
	5.0	6	6·950	75·34	52·00	3·36	361·4	369·3	130·6	...	...	...	...	...
May 20..	11.15		7·240	74·82	53·80	2·90	389·5	...	...	...	...	84	3·5	...
	12.15		7·240	74·00	53·80	2·79	389·5	389·5	135·5	...	...	...	added	...
	1.15		7·230	74·00	54·50	2·70	394·0	391·7	135·4	...	...	...	...	...
	2.15		7·240	73·90	54·40	2·69	393·8	393·9	135·4	...	...	...	...	...
	3.15		7·087	73·80	52·80	2·96	374·2	384·0	134·0	...	...	...	...	...
	4.15		7·087	73·50	52·80	2·92	374·2	374·2	132·6	...	...	...	...	...
	5.15	6	6·930	73·40	51·25	3·20	355·1	364·7	131·1	4,195	27·9	...	...	...
May 21..	11.0		7·240	74·82	54·02	2·87	391·1	...	...	...	...	10° Beaume	2	62°
	12.0		7·540	74·00	55·20	2·50	416·2	403·6	138·3	...	...	84	added	...
	1.0		7·640	73·50	55·00	2·42	420·2	418·1	142·0	...	...	...	...	...
	2.0		7·640	73·50	55·50	2·36	424·0	422·1	143·0	...	...	...	...	...
	3.0		7·540	73·50	55·20	2·43	416·2	420·1	142·0	...	...	...	...	...
	4.0		7·460	73·40	54·32	2·56	405·1	410·6	140·3	...	...	...	...	...
	5.0	6	7·425	73·20	53·75	2·62	399·0	402·0	139·3	...	...	...	...	66°
May 22..	11.0		7·399	74·50	53·50	2·84	395·8	...	...	...	...	84	2	...
	12.0		7·460	73·30	54·00	2·59	402·7	399·2	139·0	...	...	...	added	...
	1.0		7·460	73·30	54·00	2·59	402·7	402·7	139·6	...	...	...	...	...
	2.0		7·399	73·30	53·80	2·64	398·0	400·3	139·0	...	...	...	...	...
	3.0		7·399	73·10	53·50	2·65	395·8	396·9	138·5	...	...	...	...	...
	4.0		7·314	73·00	53·30	2·69	389·8	392·8	137·7	...	...	...	...	...
	5.0	6	7·240	72·75	52·50	2·80	380·1	384·4	136·2	...	...	...	...	...
		24						9477·0	3279·8					

TABLE II.—Arc Circuit.

Date. 1890.	Time.	Durati'n in hours.	Current (c) amperes.	E.M.F. volts.		Resistance of battery. Ohms.	C.E.T. external circuit. Watt hours.	Theoretic'l weight of zinc dissolved. Grains per cell.	Actual weightof zinc in grains dissolv'd per cell.	Difference between theoretical and actual consumption Per cent.	Excit'ng solution 7deg. Beaume, in quarts.	Depolariser, in quarts.	Temperature of solution. Fahr.
				Open.	Closed.								
May 5	12.30	...	6·1	69·	51·25	...	...	...	...	...	72	37	62°
	1.30	...	6·0	62·5	47·50	...	...	...	...	...	...	...	...
	2.30	...	6·0	71·75	47·50	...	...	...	...	...	...	...	...
	3.30	...	6·0	63·55	47·50	2·67	...	...	...	...	...	...	...
	4.30	...	6·0	63·55	47·50	...	...	...	...	...	...	...	...
	5.30	...	5·9	62·5	46·75	...	...	...	...	...	...	...	...
	6.30	6	5·9	62·5	46·75	...	8129·2	3318	3662	10·367	...	...	62°
May 6	11.0	...	6·0	63·55	46·12	...	...	...	...	...	...	...	62°
	12.1	...	5·9	63·55	46·12	...	...	...	...	...	...	...	...
	1.0	...	5·9	63·9	46·12	...	...	...	...	...	...	...	...
	2.0	...	5·8	63·9	45·10	...	...	...	...	...	...	...	...
	3.0	...	5·8	63·9	45·10	...	...	...	...	...	...	...	...
	4.0	...	5·8	63·9	45·10	...	...	...	...	...	...	...	...
	5.0	6	5·8	63·9	43·05	...	...	...	...	...	...	...	62°
May 7	10.30	...	6·0	64·55	48·17	...	...	...	...	...	72	3	64°
	11.30	...	5·8	65·6	49·20	...	...	...	...	...	...	added	...
	12.30	...	5·8	63·9	47·50	...	...	...	...	...	...	...	...
	1.30	...	5·8	63·9	47·50	2·83	...	...	...	...	...	...	...
	2.30	...	5·8	63·9	47·50	...	...	...	...	...	...	...	...
	3.30	...	5·8	63·9	47·50	...	...	...	...	...	...	...	...
	4.30	6	5·8	63·9	47·50	...	...	...	...	...	...	...	64°
May 8	10.30	...	6·0	63·9	45·50	...	...	...	...	...	...	2	62°
	11.0	...	6·0	63·9	46·50	...	...	...	...	...	...	added	...
	12.0	...	6·0	64·6	46·50	...	...	...	...	...	...	...	...
	1.0	...	6·0	63·9	46·12	...	...	...	...	...	...	...	...
	2.0	...	5·9	63·9	45·10	...	...	...	...	...	...	...	...
	3.0	...	5·8	63·5	44·10	...	...	...	...	...	...	...	...
	4.0	...	5·8	63·5	44·10	...	...	...	...	...	...	...	...
	4.30	6	5·9	63·5	43·05	...	...	...	...	...	...	...	70
May 9	10.30	...	6·5	63·5	41·0	...	...	...	...	...	72	2	68
	11.0	...	6·0	63·9	45·10	...	...	...	...	...	...	added	...
	12.0	...	5·9	63·9	47·10	...	...	...	...	...	...	...	...
	1.0	...	5·8	63·9	46·60	...	...	...	...	...	...	...	...
	2.0	...	5·9	63·3	46·12	...	...	...	...	...	...	...	...
	3.0	...	5·8	63·5	45·30	...	...	...	...	...	...	...	...
	4.0	...	5·9	61·0	41·00	...	...	...	...	...	...	...	...
	4.30	6	5·8	59·5	36·90	3·88	...	...	...	...	...	...	...
		30											

The daily duty, as with the incandescent lamps, was six hours of continuous work, but instead of renewing the exciting liquid each day it was drawn off at the end of a run, and used over again for the following six hours; in other words, fresh liquid was used every alternate day, and its density was kept constant at 7deg. Beaume.

The depolariser also had nothing added to make up for leakage for the first two days, but for the remainder of the time it was replenished by a small addition each morning.

The lamp used was a "Planet" arc, manufactured by the Planet Electrical Engineering Company, under Macquaire's patent, and it is perhaps scarcely necessary to add that for a given amount of electrical energy the light from an arc lamp is from seven to ten times that given by the normal incandescent; so where single lights of considerable candle-power are concerned it follows that arc lamps are more economical, but if such incandescent lamps as that known as the "Sunbeam" are employed, the difference in cost becomes less.

The temperature of the fluids at no time exceeded 70deg. F., a fact which in itself speaks well for the working of the combination.

We still consider that the Weymersch battery is the best galvanic generator of heavy currents that has yet been brought forward for domestic use, and it contains more nearly all the essentials of a theoretically perfect element than any other which we, in the course of a long and varied experience, have yet seen.

As the system is not intended in any way to compete with electric lighting by dynamo-electric machinery, but to be used solely for small installations, we think that there is a wide field of usefulness open to it.

There must be innumerable places where gas is either very dear, inaccessible, or its use unadvisable, also where the electric light would be considered a boon were it not for the great outlay necessary to set up a small private installation with engines and machinery; it is under such conditions as these, then, that the Weymersch battery could be introduced.

No engineer or electrical expert would (or ought to) think of comparing the cost of electrical energy from the steam-engine and dynamo with that entailed by the employment of primary batteries; yet to show that the cost per unit from a good voltaic combination is not so prohibitive in special cases, we may mention the Chelmsford lighting, where consumers are charged 1s. 3d. per unit. Another use for the battery is in the driving of electro motors for small electric launches, dental motors, sewing machines, and, indeed, for any purpose where low powers only are required. It seems also that the Weymersch battery is well adapted for use in connection with miners' lamps, for if, in practice, it is found that small cells are as constant as the larger sizes, it should be possible to keep running for longer shifts than with other primary battery lamps of the same weight.

Moreover, it is quite permissible to overrun incandescent lamps and obtain a higher efficiency with the absolutely constant current of a battery when the fluctuations of a dynamo-produced current would rupture the filaments; to what extent, however, this may be done remains for time to show.

We may add that since 1888 the battery has undergone very great improvements of a mechanical nature, and that the method about to be adopted for filling and emptying should render its manipulation a very easy matter for the ordinary householder or his staff of domestics; indeed, the apparatus may now be considered as quite adapted to household use.

ELECTRIC METALLURGY.

Messrs. Siemens and Halske, of Berlin, have recently patented a process for the electrical treatment of ores, of which the following are the principal points. The ore, first being pulverised, is put into a cylinder filled with a solution of sulphate of iron. The mixture is kept constantly in motion by means of moving pallets, and if there is need the bath is steam-heated. If the process is used for amalgamation, cylinders of copper, partly plunged in mercury, are placed in vessels and set in a rotatory motion. This movement assures a constant contact between them and the mineral, and the reduction takes place. In a more general case a solution of alkaline cyanide is added to the electrolyte, and an electric current is turned on. The metal is deposited on a cylinder of copper. After the operation the copper is recovered by ordinary methods. This process will be applicable in the treatment of the ores of copper, zinc, and precious metals.

THE LIMITATIONS OF STEAM AND ELECTRICITY IN TRANSPORTATION.*

BY O. T. CROSBY.

(Concluded from page 495.)

The cost of 1 h.p. hour, excited by steam locomotives, is to be obtained only by some circumlocution, the reports of cost being based on train mile. As quoted by Wellington, the coal consumed per passenger train mile on the Pennsylvania Railroad is very closely 50lb., and an average performance will show 5lb. coal per horse-power hour while *under way*. This shows that one train mile equals 10 h.p. hours. The coal consumption for a freight train mile is much higher, but the divisor would also be higher, on account of the greater number of stops, or, at least, of backing and switching, and greater delays while on a trip, thus increasing waste of coal.

Again, the Pennsylvania Railroad reports show cost of fuel per train mile of 5 cents. The cost of coal to that company, as nearly as I can learn, is about 1·50dol. per ton. Hence it would appear that 66lb. per train mile are consumed. As the terminal losses of fuel and delay (getting up steam and drawing fires, etc.) are known to be in the neighbourhood of 25 per cent. of the total consumption, we have 6·6 (lbs.) as the divisor, and the same ratio again appears.

The cost of one train mile—as to motor power alone—is given by the Pennsylvania Railroad as 22 cents. And this is practically equal to the average for the United States. The itemised statement is very carefully made up, and seems to cover everything except interest on the engine investment.

Knowing the annual mileage per locomotive to be about 20,000 and the cost to be 10,000dols. interest charge per train mile (not quite, but nearly, equivalent to engine mile) becomes 2·7 cents. Total cost becomes 24·7 cents, or 2·47 cents per horse-power hour, efficiency being constant at 100 per cent.

We may safely use this figure in the comparison to be made, since any positive error in the calculation of coal per horse-power hour, or negative error in horse-power hours per train mile, will be offset by the difference in cost of coal per ton to the P. R. R. as compared with the value assumed in Table III.

At 3dols., instead of 1dol. 50 cents, the full item would be 10 cents and the total motive power 29·5 cents. Leaving the statistics of actual cost we may reach, by the method of Table III., nearly the same figure, considering the locomotive as a 1,000 h.p. steam plant, of low first cost, burning 6lb. of coal per horse-power hour, and working at one-third capacity for about three hours per day. The result thus reached is about 10 per cent. higher, but the 2·47 cents seems most reliable.

These values multiplied into the corresponding values in the last nine columns of Table I. give the following values of:

$$\frac{\text{Power units, steam}}{\text{Power units, electric}} \times \frac{\text{cost per unit, steam.}}{\text{cost per unit, electric.}}$$

This value, Table V., being greater than unity, indicates greater economy by electricity than by steam, and *vice versâ*.

A glance at the table shows the dominating necessity of increasing the efficiency of the mechanism delivering energy from the electric line to the vehicle. We cannot count upon a higher efficiency than 90 per cent. for the motor. Hence, save in the case of putting the armature directly on

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* A paper read before the general meeting of the American Institute of Electrical Engineers, Boston, Mass., May 20, 1890.

TABLE VI.—FIGURES ON STREET-CAR TRACTION. TRACK NEARLY LEVEL.

Date.	Designation of motor-car.	Weight of motor-car and passengers.	Weight of towed car and passengers.	Length of trip in miles.	Average speed, miles per hour.	Potential at station, volts.	Ditto at car, average.	Current in motor "A." Amperes.	Current in motor "B."	Current in trolley wire of car.	Difference of "A" and "B."	Number of readings averaged.	Corresponding time interval, seconds.	Total average energy in car, in h.p.	Horizontal effort, required per ton in lbs.	Corresponding mechanical h.p.	Hysteresis, eddy currents and friction in armature "A", watts	Ditto in armature "B."	C^2 R loss in "A," watts.	Ditto in "B."	Total loss in motor or motors, h.p.	Total gearing loss, h.p.	Efficiency of motor or motors.	Ditto of gearing, one or two sets.	Ditto of motors and gearing.	Record number of run.	Remarks.
Apr 3	No. 6	Pounds. 12,000	0	3·5 and return, 7·0	9·3	480	440	6·63	6·63	13·27	A and B assumed equal except when difference was measured.	262	10	7·63	27·5	4·09	550	550	88	88	1·71	1·83	77·4	69·0	53·6	1	Track this day rather dirty. Tonnage coefficient taken 10% higher than April 20, when observations were made.
3	6	12,000	0	2·84 and return, 5·78	10·45	480	440	7·6	7·6	15·2		185	10	8·92	27·5	4·6	600	600	115	115	1·97	2·4	78·0	65·7	51·5	2	
3	8	12,000	0	2·84 and return, 5·78	11·5	480	440	11·85	0	11·85		145	12	6·96	27·5	5·06	675	0	230	0	1·2	0·7	82·7	87·8	72·7	3	Armature of motor "B" taken out for this and trip No. 4.
3	8	12,000	0	3·5 and return, 7·0	9·1	480	440	10·0	0	10·0		230	12	5·87	27·5	4·0	550	0	200	0	1·0	0·87	83·1	82·1	68·0	4	
20	8	11,850	6050	2·84 and return, 5·78	10·0	480	440	7·85	7·85	15·7		144	15	9·25	25	6·0	600	600	123	123	1·94	1·31	79·0	82·0	64·8	5	Dynamometer between motor & tow car. 131 readings taken.
20	8	12,000	7200	2·84	8·3	480	440	12·26	0	12·26		85	15	7·23	25	5·31	500	0	300	0	1·07	0·85	85·2	86·0	73·0	6	Motor "B" cut out of circuit.
May 2	8	12,400		2·84 and 3·5 6·34	10·9	480	440	7·68	5·52	14·2	1·16	131	15	8·37	25	4·5	650	650	118	61	1·98	1·89	76·3	70·4	53·7	7	Separate ammeter in each motor circuit and in main.

NOTE.—Voltmeter readings taken April 3 and 20 assumed same values May 2. Traction coefficient also taken from April 20, as track was in same condition. Losses in motors cannot be given with perfect accuracy, as they have not been determined for wide ranges of condition by shop tests. Values for hysteresis, etc., here taken correspond closely with several shop tests. Except C^2R, motor loss does not vary largely with current flowing in practice, as with a low current a very large armature induction is effected. The "R" in C^2R cannot be known accurately, as it constantly changes with change in position of switch. A fair average of switch position was obtained from observation. Total error in motor losses probably not greater than 10 per cent. Run No. 7 not introduced here for discussion of difference of action of motors "A" and "B."

Average efficiency whole mechanism, two motors = 55·9 per cent.
" " " one motor = 71·2 "
" " one motor alone .... = 83·6 "
" " two motors " .... = 77·6 "
" " two sets gears alone .... = 71·8 "
" " one set gears .... = 85·3 "

the axle, we cannot hope to reduce the total loss to less than 20 per cent.—a case permitting one set (*i.e.*, two gears) of spur gearing between armature and axle. As the ordinary relation between tonnage and resisting area will lie between the second and third columns of each efficiency table, it appears that with a 20 per cent. loss electricity becomes cheaper than steam at about 70 miles per hour.

TABLE V.

Ratios of cost of motive power.

Efficiency of electric engine.	10 per cent.			20 per cent.			40 per cent.		
Tonnage and area relation.	2 & 3	2 & 5	2 & 8	2 & 3	2 & 5	2 & 8	2 & 3	2 & 5	2 & 8
Speed.									
20	1·15	1·16	1·16	0·92	0·85	0·85	0·56	0·56	0·55
40	1·19	1·19	1·17	0·95	0·95	0·95	0·57	0·57	0·56
60	1·25	1·24	1·19	1·00	1·00	0·95	0·58	0·58	0·56
80	1·33	1·32	1·22	1·07	1·03	0·94	0·59	0·59	0·57
100	1·58	1·42	1·32	1·23	1·20	1·05	0·66	0·65	0·59
120	2·57	1·94	1·47	1·66	1·49	1·13	0·80	0·78	0·64
140	10·03	3·82	1·87	7·35	2·83	1·46	2·72	1·36	0·72

In the case of 40 per cent. loss our new agent betters the old only at 140 miles per hour. And yet this loss—40 per cent.—is about the best we do with our present systems of electric propulsion. This appears from the following tabulation of results obtained by me on the Brooklyn and Jamaica Electric Railway, Table VI.

Considering the very short life of the art, these results are excellent. Indeed, excellence is shown in the mere fact of success in competing with horses under conditions very trying for any mechanism not made of indiarubber or whitleather. How great that success has been I need not here proclaim. But the steam locomotive is a foeman more worthy of our steel, or, rather, of our annealed soft iron, and 99 per cent. copper.

Consideration of all that precedes leads to the following general conclusions:

1. A slow-speed armature placed on the car axle would place the electric motor in the lead at all service speeds.

2. For speeds above 70 miles per hour an electric motor of 90 per cent. efficiency, working through gearing of 90 per cent. efficiency, would prove more economical than the steam locomotive, save in cases of very infrequent service on very long lines.

3. On lines for heavy traffic steam would be more economical than electricity, if motor and gearing have a combined efficiency as low as 60 per cent. up to 100 miles per hour.

4. At speeds of 100 miles per hour and upwards neither steam at 90 per cent. nor electric apparatus at 60 per cent. efficiency is commercially practicable.

5. Inasmuch as the saving of coal in stationary, as compared with locomotive engines, is one of the chief causes of the greater economy of electric propulsion, at any speed, this advantage will increase with that difference and also with the price of coal.

6. Any cause, other than inefficiency of motor which increases the power required to haul a ton of freight, increases the advantages of electricity, since it enlarges the value of the coal difference and the dead-weight difference.

Thus bad roadways and large areas exposed to atmospheric resistance, as in street railway work, lower the speed at which electric motors of any efficiency become cheaper than steam.

7. In descending to small locomotive units, the electric motor loses less, relatively, of its advantage—another reason for success on street lines.

8. Multiplying the number of motors should be, as far as possible, avoided.

9. In special cases, cleanliness and compactness of electric machinery may be of great value; in case of very frequent stops, the possibility of returning to the line the energy now wasted in brakes may be of considerable value. This, however, can be obtained only by sacrifice in the matter of dead weight, as normal working is implied be at comparatively low magnetisation. Loss due t

efficiency in starting can scarcely be avoided either in steam or electric engines.

10. Other minor pros and cons may be enumerated, but I believe that in considering the general economic results of the two systems we reach more definite conclusions.

While only one condition of station working has been taken for final comparison, that case is an average one, and comparative results would be but slightly affected by ordinary variations. Extreme cases may be readily determined from the tables and formulas presented.

11. Some differences of opinion as to the proper values for the various constants are to be expected, but I believe these differences, taken all along the line, would nearly balance between positives and negatives, leaving the general results and the method unchanged.

NEW COMPANIES REGISTERED.

Kent Patent Arc Lamp Company, Limited.—Registered by Leslie, Antill, and Arnold, 1, Gresham-buildings, E.C., with a capital of £10,000 in £5 shares. Object: to acquire any patents, licenses, or concessions in connection with electric or other lighting or illuminating purposes, in accordance with an agreement made between J. Kent and A. Salter. Most of the regulations of Table A apply.

William Beale and Co.—Registered with a capital of £75,000, in shares of £1 each. Beales', Limited, has been formed to acquire the business of William Beale—trading as W. Beale and Co.—of 370, 372, and 464, Holloway-road, London, public caterer, restaurateur, baker, confectioner, retail cake and biscuit manufacturer, general provision dealer, licensed victualler, and electric light and power contractor. The purchase price is £43,000, payable £15,000 in shares, and the balance in cash. The vendor guarantees a minimum dividend for the first three years of 6 per cent.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The receipts for the week ended June 20 amounted to £4,098.

Western and Brazilian Telegraph Company, Limited.—The receipts for the week ended June 20, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,154.

Telephone Company of Austria, Limited.—Coupon No. 11 of the 5 per cent. debentures of the Telephone Company of Austria, Limited, will be paid, less income tax, by Messrs. Martin and Co., 68, Lombard-street, on and after the 1st proximo.

Manitoba Electric and Gas Light Company.—Messrs. Robert A. McClean and Co. notify that the half-yearly interest on the first mortgage bonds of this Company will be paid on July 1. Coupons must be left three clear days for examination.

Anglo-Portuguese Telephone Company, Limited.—Coupon No. 5 of the 6 per cent. debentures of the Anglo-Portuguese Telephone Company, Limited, will be paid, less income tax, by the Alliance Bank, Bartholomew-lane, on and after the 1st proximo.

Laing, Wharton, and Down, Limited.—The Directors of the Laing, Wharton, and Down Construction Syndicate, Limited (Thomson-Houston system), at their meeting held on Tuesday, decided to recommend to the shareholders, at a meeting to be held on the 18th July next, the declaration of a dividend at the rate of 5 per cent. per annum for the period ending the 31st March last. The balance-sheet of the Company shows a profit at a rate of nearly 9 per cent. per annum, out of which a considerable sum will be carried to reserve.

West African Telegraph Company, Limited.—The report of the Directors of this Company for the 12 months ended December 31, 1889, states that the revenue amounted to £64,661, against which £21,155 is charged for ordinary expenses, £1,780 for hire of cable-repairing ships, and £510 for income tax, leaving a balance of £40,486, which, with £4,878 brought forward from the preceding year, makes a total of £45,344. From this amount is deducted £17,644, being for interest on debentures £14,477, and for sinking fund £3,167, leaving a balance of £27,700, out of which the Directors have placed £16,146 to a general reserve fund. The shareholders have received for the six months ending June 30, 1889, an interim payment amounting to 3s. 6d. per share, and the Directors now recommend a dividend of 6s. 6d. per share, making up 5 per cent., free of income tax, for the year ended December 31, 1889, which, with the appropriation to the general reserve fund of £16,146, will absorb the balance standing to the credit of the revenue account. The Directors have, in addition to the amount of £16,146 taken from this year's revenue account, placed the balance of £3,074, which was standing on the repairs and renewals account, to the general reserve fund. With the interest received during the year from investments—£493—this fund now amounts to £19,713.

PROVISIONAL PATENTS, 1890.

June 16.

9261. **A new or improved electric arc lamp.** Ernest Thomas Headech, 61, Falmouth-road, New Kent-road, London.

9263. **Improvements in electric cut-outs and switches or other circuit breakers.** John Drummond, 17, St. Ann's-square, Manchester. (Richard Oliver Gardner Drummond and David Alexander Bremner, South Africa.)

9274. **Utilising the waste or other water power of rivers, canals, tides, etc., etc., for electrical or other purposes, by constructing or erecting lock, shute, or other weirs with hollow iron piers and foundations or casings upon iron screw or ordinary piles, and filling with concrete, etc., to carry water wheels or encased dynamo water wheels of any kind, or by floating dynamos on such dynamo water wheels.** Philip Henry Williams, Egham, Surrey.

9275. **Constructing water wheels of any form, and providing or utilising space in the interior for enclosing or attaching dynamos of any kind, or attaching encased dynamos to water wheels of any kind, or to their spindles or shafts, or floating dynamos.** Philip Henry Williams, Egham.

9284. **Switches for making and breaking electric circuits.** William Harding Scott and Laurence, Paris, and Scott, Limited, Gothic Works, King-street, Norwich.

9289. **Improvements in electric motors.** Charles E. Nichols, 10, Shalcomb-street, King's-road, Chelsea.

June 17.

9330. **Improvements in the electrolysis of chlorides, and apparatus therefor.** William Henry Dowland and Walter Mills, 54, Glengall-road, London.

9343. **A new and improved flexible-jointed pipe for fluids, gases, &c., and for insulation of electric or other wires.** Robert Morris Hague, Eastfields, Newbury, Berks.

9357. **Improvements in switches for electric glow lamps.** Albert Barker, 78, Fleet-street, London.

9361. **Improvements in electric reduction of metals, and in apparatus therefor.** Thomas Leopold Willson, 55, Chancery-lane, London.

9395. **Improvements in electrical apparatus for the production of rotary motion.** Otto Romanze, of and on behalf of the firm of Romanze and Weise, and Frederick William White, 4, South-street, Finsbury, London.

June 18.

9429. **An improved insulator for telegraphic or other purposes.** Edward Baines, Market-place, Huddersfield.

June 20.

9602. **Improvements in the distribution of electrical energy.** Siemens Bros. and Co., Limited, 28, Southampton-buildings, London. (Siemens and Halske, Germany.)

June 21.

9668. **Improvements in elevating and lowering electric lights.** John Peter Hebendahl, George Miller, and Edwin Franklin Warner, 151, Strand, London. (Complete specification.)

9683. **Improvements in electrically driven percussive tools, and in the means of operating the same.** Llewelyn Birchall Atkinson, of the firm of W. T. Goolden and Co., 1, Queen Victoria-street, London.

SPECIFICATIONS PUBLISHED

1880.

3880. **Conductors for electricity.** Jensen (Edison). (Fourth edition). 8d.

1889.

8973. **Secondary batteries.** Bosshardt (Verdier). 8d.

14162. **Treating alcohol by electricity.** De Méritens. 4d.

1890.

3544. **Electric telegraphy.** Patten. 2s.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Anglo-American Brush	—	2¾
— Pref.	—	2⅛
India Rubber, Gutta Percha & Telegraph Co.	10	20
House-to-House	4½	5
Metropolitan Electric Supply	—	5¾
London Electric Supply	5	2¾
Swan United	3½	5½
Crompton & Co., Pref.	—	5½
National Telephone	5	5¼
Electric Construction	10	10